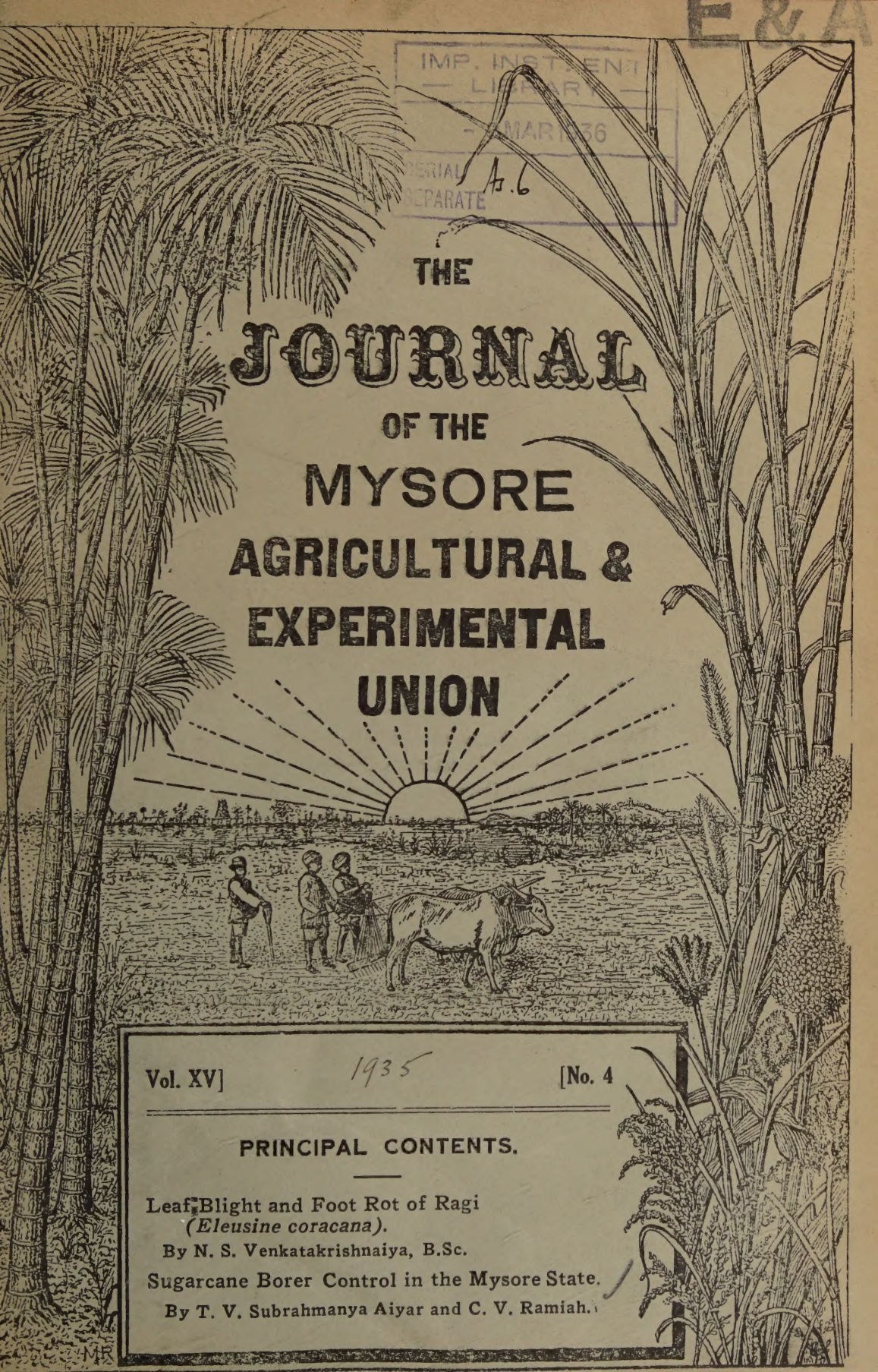
IMP. INSTITUTE LIBRARY
7 MAR 1936
SERIAL SEPARATE
A.6
E&A

THE JOURNAL OF THE MYSORE AGRICULTURAL & EXPERIMENTAL UNION



Vol. XV] 1935 [No. 4

PRINCIPAL CONTENTS.

Leaf Blight and Foot Rot of Ragi (*Eleusine coracana*).
By N. S. Venkatakrishnaiya, B.Sc.

Sugarcane Borer Control in the Mysore State.
By T. V. Subrahmanya Aiyar and C. V. Ramiah.

CONTENTS.

PAGE

Leaf Blight and Foot Rot of Ragi (*Eleusine coracana*)—
By N. S. Venkatakrishnaiya, B.Sc., Jr. Asstt. Mycologist .. 125

Sugarcane Borer Control in the Mysore State—
By T. V. Subrahmanya Aiyar, Dip. in Agri., Entomologist and C. V. Ramiah, Superintendent, Irwin Canal Farm .. 130

Cultivation of Turmeric in Hassan Taluk—
By N. Ramanna, B.Ag., Agricultural Inspector 136

Arachis hypogæa, Linn. Groundnut or Peanut—
Original Habitat and its Distribution in the World
By V. K. Badami, L.Ag., Ph.D. (Cantab.) 141

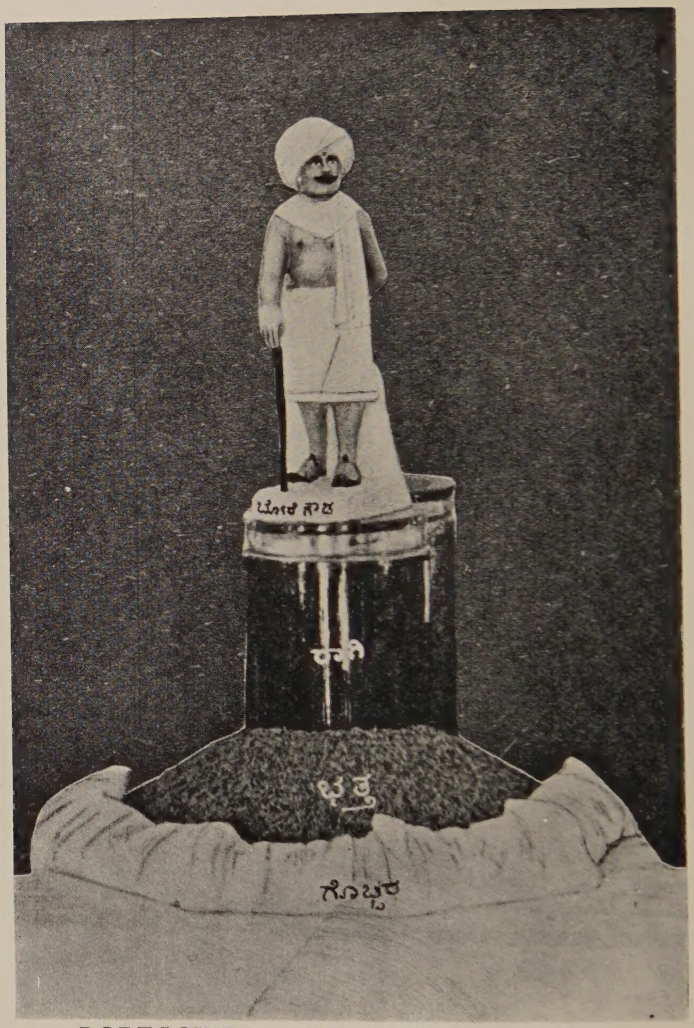
Editorial 154

SELECTIONS & ABSTRACTS—
Changing the Sex of Papaw Trees—Tobacco, A New Source of Citric Acid—Attitudes of High School Seniors towards Farming and other Vocations—Cooking American Varieties of Rice—Potato Growing in Victoria—Termites or White Ants—Agricultural Marketing in India 156

Our Exchange List 176

NOTICE

Members and Subscribers are requested to intimate promptly to the Union Office change of their address as otherwise, letters and journals sent to them are likely to be delayed or missed altogether.



BOREGOWDA, THE MYSORE FARMER.

His prosperity is the State's prosperity. That is built upon good cultivation, timely operations, rational manuring, use of pedigree seeds, control of insect pests and plant diseases and intelligent marketing.

The Journal
of the
Mysore Agricultural
and
Experimental Union

Vol. XV] [No. 4

Leaf Blight and Foot Rot of Ragi (*Eleusine coracana*)

By

N. S. Venkatakrishnaiya, B.Sc., *Jr. Asstt. Mycologist*

Ragi (*Eleusine coracana*), the chief dry crop and staple food of 80 per cent. of the population in Mysore, is fortunately subject to very few diseases. But, of these, the leaf blight disease caused by the fungus *Helminthosporium nodulosum* has been known to be prevalent for several years, and causes considerable damage to the crop. Extensive work on similar diseases of barley, wheat, rye, oats and many other cereals and grasses has been carried out in other countries by various investigators. In India, the fungus, as recorded by Butler[2] and Mitra,[1] attacks many cereals such as barley, oats, maize, jowar, paddy, etc. Mitra[1] has made a detailed study of different species of *Helminthosporium* occurring on cereals, sugarcane and other cultivated crops. The disease on ragi as mentioned by Butler[2] is caused by a similar fungus to those that cause the leaf blights of barley, maize and jowar.

1 Mitra, M., "A comparative study of species and strains of Helminthosporium on certain Indian cultivated crops," *Trans. Brit. Myco. Soc.*, Vol. XV, 1931.

2 Butler, E. J., *Fungi and disease in plants*, 1918.

Coleman[3] observed this disease on ragi in Mysore as early as 1916. The severity of the disease has however been felt during recent years.

Symptoms :—The disease is usually observed in the field on plants scattered throughout the crop and sometimes in patches confined to definite areas. It may appear at any time during the life of the crop, the causal fungus attacking almost all the parts of the host from foot to head. The disease is easily recognised at first sight by the characteristic brownish spots on the leaves and culms (Fig. A).

On the leaves, the disease usually appears as numerous, small, rusty brown, oval or irregular spots. The spots which are generally longer than broad elongating parallel to the axis of the blade appear on both the surfaces of the leaf and often coalesce with one another. The appearance and size of the spots vary greatly. The fungus causes similar blotches on the culm, leaf sheath, rachis spike and spikelets. In severe cases of infection the base of the plant also is discoloured by the fungus with large brown lesions. The entire earhead or portions of it often present a dried appearance in contrast with the healthy green spikelets. The grains in the infected portions of the spikelets do not develop to their normal size as compared with the healthy ones (Fig. B). Some of the infected spikelets do not contain any grains at all or have only poorly developed ones.

The disease assumes a severe epidemic form when the climatic conditions are most favourable for the spread of the pathogene on the host ; weather conditions being of course the predominant factors for the spread of the disease. Heavy continued rainfall with cloudy weather followed by dry weather appear to be very favourable for the rapid development and spread of the disease. The disease has been noticed to be serious during years of excessive rainfall. It was particularly so during the year 1932 when the rains were unusually

[3] Coleman, L. C., "The cultivation of Ragi in Mysore," *Mys. Agl. Deptt. Gen. Ser. Bull.*, 11, 1916.

Since this article was sent up for publication an article on diseases of *Eleusine coracana* and *E. Aegyptiaca* caused by Helminthosporium by Mitra, M. and Mehta, P. R., has appeared in the *Ind. Jour. Agri. Sci.*, Vol. IV.

Fig. A. Photograph of an affected culm of Local *Hullubele* from an infected plot on Hebbal Farm. Characteristic blotches are seen on the culm and leaves.

Fig. B. Photograph of an affected earhead from an infected field near Bangalore showing poor development of grains at the infected portions of the spike with few normal grains down below.

heavy. Infection was very common during the year in almost every field visited round about Bangalore. The disease does not usually appear conspicuously until very late in the life of the plant. It generally manifests itself rather virulently when the crop begins to bear earheads thus diminishing the vigour of the plant just at the time when it is most required and resulting in the premature ripening of the ears and impoverished grain yield.

Varieties affected :—No variety seems to be free from the attack of this fungus though there is some difference between the susceptibility of the disease on different varieties. The local *Hullubele* or *Dodda* ragi, the most widely cultivated variety in Mysore and the *Kar* or *Gidda* ragi, the early cultivated variety, appear to be most severely affected ones. Almost all the varieties cultivated in 1932 on Hebbal Farm, *viz.*, Local *Hullubele*, H_{45}, H_{55}, H_{77}, H_{73}, H_{71}, H_2, H_{40}, and H_{22} were observed to have been affected with the disease. H_{22} variety appears to have been so far the least susceptible to the disease.

Life of the pathogene :—The fungus is not only able to attack living plants but can also live on dead or decaying matter thus surviving on remains of old straw left in the field after the crop is harvested. It sporulates very abundantly in nature on the spikelets. The large number of dark brown conidiophores bearing the long cylindrically shaped conidia are very easily observed with the aid of a powerful lens on fresh glumes and grains. Spores of the pathogene are also found on the lesions of leaves and culms though not as abundantly as on the spikelets. Experiments in the laboratory have shown that the spores and mycelial threads from these parts are capable of reproducing the disease on fresh plants even after a year.

Spores on fresh spikelets as well as those obtained in pure culture germinate readily in water in very short time in less than half an hour. Spores get detached from the conidiophores very easily and are probably disseminated through the agency of wind and thus the disease spreads from plant to

plant and from one plot to the other under favourable atmospheric conditions.

The fungus in pure culture isolated from the different affected parts of the host grows well on media ordinarily used in the laboratory. It grows luxuriantly and sporulates freely on oat, onion, ragi and potato dextrose agars than on Richard's, Beyerinck's, malt, nutrient and tap-water agars. The mycelium is brownish while the conidia and conidiophores are deeper in colour. The conidiophores are simple, septate and measure from 100 to 300 μ by 4 to 7 μ. The conidia are mostly club shaped, curved, rounded at both ends, and 3-10 septate transversely. They measure from 25 to 100 μ by 12 to 20 μ. Germination takes place readily in distilled water either from one or both end cells of the spore. The germ tubes are hyaline and new spores are formed in culture in a few days. The aerial growth of mycelium, sporulation, size and shape of the spores vary on different media. Formation of sclerotial bodies has been observed in culture. The fungus shows on oat meal, ragi and Blakslee's media the good formation of sclerotia. These are fairly large bodies measuring even 80 to 100 μ.

In the laboratory inoculation experiments have shown that the organism is capable of attacking the various parts of the host both young and old. Under moist conditions inoculation into healthy plants of an aqueous suspension of mycelial threads and spores from pure cultures reproduced the disease within three days.

Spores and mycelial threads with thick giant cells ramifying on the husk have been observed to be present on the seed. These are found to be also viable. Experiments have shown that these spores and mycelial threads are capable of withstanding the vicissitudes of nature. As such it is possible that the infection is carried over either through the affected seed or infected soil or from both.

Control methods :—Since the disease has been found among other things, to be seed borne, experiments with disinfection of seeds by means of fungicides such as copper

sulphate solution of 1% and ½% strength and ceresan—a proprietary fungicide prepared by I. G. Farbenindustrie, Aktiengeselschaft, Germany—are under study. 86% of the seeds germinated when they were treated for six hours with ½% copper sulphate solution and for 2 hours with 1% copper sulphate solution. With ceresan which has been successfully used in other countries for similar seed-borne diseases the percentage of germination of treated seeds at 2 to 2½ ozs. per bushel of seed has been found to be 85% to 95% while the untreated seeds showed only 68% to 93%. The treatment does not affect in any way the germination of seeds.

Seedlings on agar in large test-tubes from seeds disinfected with ceresan came up healthy while the control ones showed the discolouration and infection of the disease. A preliminary trial on a field scale of the seeds treated with ½% copper sulphate solution, ⅛% ceresan solution, ceresan dust, and Abavit B carried out on the Hebbal Farm seems to be promising.

Seed disinfection though effective in destroying the fungi carried by the seed grain cannot prevent infection due to the occurrence of the fungus upon the straw and culm in infected fields. Besides, the fungus is capable of living on the stubble in the field and the spores retain their viability over a considerable period of time. This last can only be prevented or at any rate controlled by good cropping methods. Losses due to *Helminthosporium nodulosum* can therefore be minimised by employing disinfected seeds or seeds grown in a healthy field and adapting good cropping methods.

In conclusion the writer is greatly indebted to Mr. M. J. Narasimhan, Mycologist, for kind encouragement and guidance during the course of this work.

Sugarcane Borer Control in the Mysore State

By

T. V. Subrahmanya Aiyar, Dip. in Agri., *Entomologist*

AND

C. V. Ramiah, *Superintendent, Irwin Canal Farm*

In the article "Sugarcane borers and their control in the Mysore State" published in this Journal, Vol. XIV, No. 3, it was pointed out that there are two kinds of dead heart borers damaging young canes, *viz.*, *Argyria sticticraspis* and *Diatræa venosata*, that the former are more numerous and do the greatest amount of damage. The life-history of the insect and the nature of the injury caused to the canes have also been briefly mentioned there.

The various borer control methods recommended in the above circular and adopted by many of the sugarcane growers in the Irwin Canal area are :—

(1) the selection of borer-free cane setts for planting;
(2) trash bundle method of trapping the borer moths;
(3) removal of dead heart shoots;
(4) collection of borer egg masses;
(5) release of the natural enemies of the borer eggs in the field ;
(6) good cultivation.

A very close study of the habits of the young larvæ in the field and of their mode of attack has made it possible to devise a very simple control which is set forth in this article.

Habits of the Young Larvæ.

Careful observations made on the habits of the young larvæ hatching out of the egg masses laid in the sugarcane leaves revealed that most of the larvæ after wandering about for a short time on the leaves are found either to crawl down the stem of the young cane or get distributed by the wind if the weather is very windy or let themselves down to the surface of the ground by means of a silken web. Some of those that crawl down the stem find a good shelter in between the

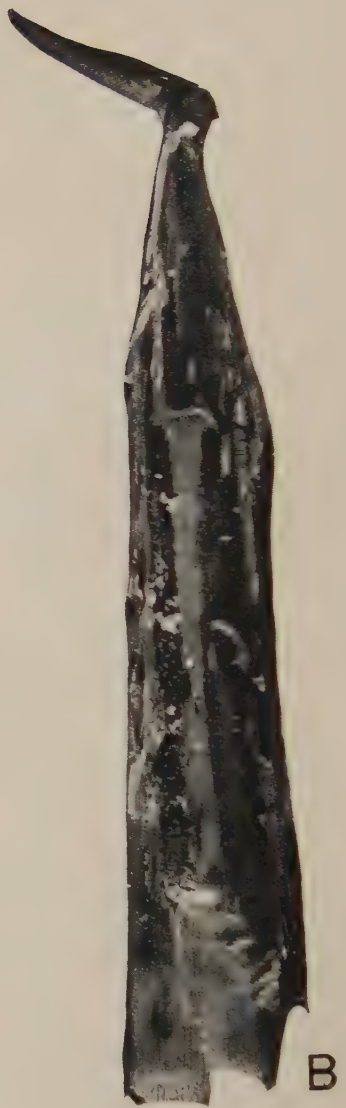


Plate I-A.—Sugarcane seedling about five weeks old showing the top portion of the first leaf sheath a little detached from the stem.

Plate I.-B.—Leaf sheath removed from a cane seedling. A few larvæ are seen on the right side. The bottom left shows a lot of frass thrown out by the larvæ remaining within the tissue.

first leaf sheath and the stem of the plant. This is the only leaf sheath on the plant that is found with its top portion a little detached from the stem when the canes are about 4 to 5 weeks old (Plate I, Fig. A.). The other larvæ too, after wandering about on the ground for some time, are found to crawl up the stem and get into the leaf sheath and join other larvæ that are already there. It is not all the larvæ that hatch out of an egg mass that are able to get into the shelter mentioned above, for, more than 25 to 30 per cent. of the larvæ are either destroyed by enemies, mostly ants or by irrigation during their wanderings on the young cane field.

As the larvæ are very young, they have not been found to be able to bore into the cane stem immediately but they remain feeding on the inner surface of the leaf sheath and their behaviour is now more or less very much like a LEAF-MINER. In a badly borer-attacked young cane area, if a leaf sheath is removed and examined, numerous larvæ of varying ages may be found tunnelling into the tissue of the leaf sheath (Plate I, Fig. B). Small circular portions of the inner surface of the leaf sheath eaten up by the very young larvæ will also be found. From their first entry into the leaf sheath, the larvæ remain feeding for about five to six days on the succulent tissue of the leaf sheath and later they bore holes on the stem, near the soil surface and get into the core of the stem, thus causing a dead heart.

The larvæ remain within the stem feeding on the soft internal tissues of the young cane seedlings and damaging the growing shoots of the stem up to the very root portions. It is now that the characteristic "dead hearts" are noticed in a cane field. When the larvæ inside the cane seedling find all fresh food exhausted in the stem, they get out of the stem one after the other and attack or destroy the vigorously growing tillerings that appear now. Thus, the young canes do not get any chance of growing up at all. The greatest damage to the young cane seedlings has been found to be caused by the borers, when the former are from four to five weeks old. Any control measures adopted during this period of the

growth of the cane go a great way in the establishment of a very healthy and vigorous stand of canes.

Control Methods.

Leaf Sheath Removal.—As it has been found that the first leaf sheath affords shelter to the young borer larvæ, the first method of control adopted was the removal of these leaf sheaths from rows of four to five weeks old canes in a field. These leaf sheaths will now be found to have just separated from the young cane shoots and the destruction of these with the larvæ found in them by dropping them into a vessel containing a little kerosened water was found to markedly reduce the population of the borer larvæ and the appearance of dead hearts in the field.

Earthing up and Irrigation.—A second method of control, suggested by C. V. Ramiah, for application on a field scale was the earthing up of the young sugarcane plants by means of a light mould-board plough—Eureka or Meston, hitched on to a pair of bullocks. By a light earthing up the soil on both sides of the cane rows was thrown over the young cane shoots covering up the first leaf sheaths. A good irrigation given soon after made the loose heaped-up soil to settle down around the shoots. By the above methods, it was expected that most of the young larvæ remaining in the shelter of the leaf sheath and the stem would get smothered and the older larvæ already within the tender stem would not have much chance to get out of the stem easily, because of the mass of the soil around the stem.

Experiments were conducted on the Government Sugarcane Farm, Mandya, to test the efficacy of the above methods, in the control of the "dead heart" borers.

A suitable cane field of about one acre, four weeks from planting, was taken up for the experiments. Three experiments, *viz.*, leaf sheath removal, earthing up and a combination of both were conducted and each experiment was repeated three times. A good irrigation was given to the plots where earthing up was done soon after this operation

was completed. A second earthing up was also done a month later.

Table giving a summary of the experiments carried out in the Government Sugarcane Farm, Mandya.

	Leaf sheath removal	Leaf sheath removal and earthing up	Earthing up
Percentage of dead hearts ..	24·3%	10·7%	14·6%
Number of tillerings affected per acre	2,330	620	1,090

Very careful observations were made after six days on the effect of earthing up and irrigation on the borer larvæ in the leaf sheaths and stems. Our expectations were more than realised, for out of one hundred cane seedlings selected at random and examined, 34 were found with borer larvæ in the leaf sheaths and stems. A total of 120 larvæ was obtained, of which 102 (85 per cent.) were found dead and 18 (15 per cent.) were alive. Out of the latter, 12 of about two weeks old were found within the stems and had caused dead hearts and the other six, more or less of the same age as above, were found wedged in between the leaf sheath and the stem on different plants. It has also been found that many of the older larvæ are capable of getting out of the stem and damaging the adjacent tillers by boring through the soil, particularly in stony soils. The dead hearts noticed appearing in the field some time after earthing up and irrigation are mainly due to the older larvæ but the damage done to the cane seedlings has been found to be negligible. To minimise this, the dead hearts should be removed with the larvæ by cutting the shoots carefully as far as the root portions.

Effect of Earthing up on Tillering and Vigour of the Crop.

It was apprehended that the earthing up might retard very much the growth of the new tillerings and damage the cane seedlings by affecting their root system.

It was however found that a light earthing up never affected the cane shoots or the tillerings, although there was a very slight delay in the appearance of the latter above the heaped-up earth and instead of any damage to cane seedlings, it appeared to have acted as a stimulant to the growth of the canes. The growth and vigour of the canes in the earthed-up rows appeared to be much better than the same in the rows not so treated.

Irrigation of the young cane after earthing up may appear to be difficult as it destroys irrigation channels but this is set right by interculturing and irrigating between the rows of cane. This latter operation not only helps a great deal in keeping down weeds, but the cost of weeding is also greatly reduced.

Effect of Earthing up on the Production of Dead Hearts.

It has already been stated that as a result of a light earthing up 85 per cent. of the young borer larvæ were found dead and only 15 per cent. of the larvæ were alive.

It will thus be seen that as most of the young larvæ are killed, the number of the dead hearts in the field is markedly reduced. It will be seen from the table given above that in the area where both leaf sheath removal and earthing up was done, the dead hearts and the number of tillerings affected by the borer are at a minimum as compared with the areas that received one kind of treatment alone. In order to get the maximum effect of the treatment against the borer, both the operations of leaf sheath removal and a light earthing up will have to be done in a young cane field.

Fate of the Larvæ that Hatch out from Eggs Laid after Earthing up.

The larvæ hatching out from eggs laid after earthing up are unable to get into the stem from the leaf sheath shelters because of the mass of soil around the plants. Many of these crawl over the leaves and get some shelter at the base of the central whorl of the leaves. Here they behave like the

top shoot borer feeding on the leaf tissue and trying to get into the stem, but not much damage has been noticed to the growing shoot and the larvæ have not been found deep down in the stem. Even if the top portions of the shoot have been found damaged a little, no appreciable damage is noticed owing to the very vigorous and rapid growth of the seedlings.

If a second appearance of dead hearts is noticed on the grown-up tillerings about four or five weeks after the first earthing up, a second earthing up may be necessary.

Conclusion.

As the dead heart borers cause the greatest amount of damage to young canes, when the latter are from four to five weeks old, sugarcane growers are strongly advised to resort to the following methods of control to minimise the borer attack to a very great extent. The methods are to be adopted as soon as a few dead hearts have appeared in a field.

(1) Remove the first leaf sheaths of canes as these contain a large number of borer larvæ of varying ages and destroy them by dropping them into a vessel containing kerosened water.

(2) Give a light earthing up by means of a mould-board plough. In case of cultivators who do not possess one, the earthing up may be done by means of a spade. Care should be taken to see that only the first leaf sheath is fully covered up.

(3) Give a good irrigation immediately after earthing up.

(4) Remove the dead hearts already present by cutting out the shoots close to the roots with the larvæ present.

(5) Systematically collect borer egg masses from the fields with the aid of children who are able to do this very efficiently with a little practice.

(6) Put the egg masses collected in a perforated zinc box, placing the latter in the cane field on a basin of kerosened water, thus enabling the egg parasites if any to escape to the fields and continue their work of egg-mass destruction.

(7) When the cane crop is about eight or nine weeks

old, go over the whole field and cut away the few dead hearts that may be found close to the level of the ridge formed by the first earthing up. Give the crop another earthing up immediately; this operation buries down the stumps left after cutting away the dead hearts and prevents borer moths that may emerge from the full grown larvæ in these stumps.

Cultivation of Turmeric in Hassan Taluk

By

N. Ramanna, B.Ag., *Agricultural Inspector*

Turmeric is grown in the Hassan Taluk on wet lands, mostly in a few villages of Kattaya Hobli (Sattigarahalli, Karle and Avverahalli), where it occupies an area of about 50 acres. The soil of these parts seems to be well suited for its cultivation. It is not grown in garden lands as the roots of other plants in the garden and drippings from plants above are considered to check its growth. Usually not more than 10 to 15 guntas are put under the crop by one ryot as it requires intensive cultivation and much attention. It is mainly rainfed and grown by the ryot himself on his own lands.

Climatic conditions, etc.—Extremes of temperature are not conducive to its growth. It is enough if the rainfall is fairly heavy at the time of planting, *i.e.*, during the Bharani rains and also during the first two months of planting. Percolation of water into the lands where the crop is grown and drainage for the removal of excess of water to prevent logging are essential conditions for turmeric cultivation. Black soils with admixture of limestones are best suited; in the case of clayey soils they should be replenished with tank silt containing limestone nodules.

Turmeric is usually rotated with paddy as, otherwise, the soil fertility would be very much depleted.

Preparatory cultivation.—Clods of earth, if any, are allowed to be acted upon by heavy showers that fall during

Aswini and Bharani (April and May). Land is ploughed four or five times thereafter with a country plough. One-way rows at two feet apart are prepared by means of the plough.

Manure.—Cattle manure is applied to the rows thus made. Silt containing limestone nodules is also generally applied and mixed thoroughly with the earth by ploughing. Eight to ten cart-loads of cattle manure and twenty to twenty-five cart-loads of silt are the usual doze for a plot of ten guntas.

Seed.—Growers take care to select only the best rhizomes. Each seed to be planted has the appearance of a potato tuber. Germination will have begun in such seeds even before planting. Seeds required for planting are preserved in the following manner. They are loosely heaped in a corner of the house and covered over with a layer of paddy hay to keep them warm. Over this layer of hay a thin coating of cow-dung plaster is given and the seeds allowed to remain in this condition for about two months till the time of planting. The coatings of plaster and hay are removed when the seeds are required for planting. The seed rate is 30 maunds for 10 guntas.

Planting.—Seeds are planted at one foot apart at a depth of four inches in the two feet rows prepared as mentioned above and covered with earth to avoid exposure. It takes about a month's time for the first leaf to appear. The leaf which will be closely rolled up like the plantain leaf takes 8 to 10 days to unfurl itself.

After cultivation.—In about three fortnights after planting every seedling will have put forth a few leaves. That is the proper time for weeding. The plants are not irrigated until it is December when only, water is admitted into the drains dug all round the plot. Water in the drains has to percolate into the field and feed the crop. Direct irrigation is not practised as it spoils the crop. Earthing up is done with spades (*guddali*) a fortnight after weeding. No more attention is given thereafter until the time of harvest.

Harvest.—Turmeric crop grows to a height of two feet. November is the flowering season. Some ryots are in the habit of removing these flowers. Harvesting commences from the second week of January and lasts until the first week of February. The tubers will have gone to a depth of one foot and spread in a claw-shape fashion all round to a distance ½ a foot from the centre. In each plant, ordinarily, there are eight to ten fingers, out of which two to six are well developed. Manual labour is employed to dig out these tubers and it is done by means of pickaxes.

Curing and marketing.—All the finger-like processes at the sides of the rhizomes are detached from the central tubers which are generally preserved for seed. If the central piece is found to be unfit, it is not used for seed. The rhizomes are removed to the threshing yard immediately they are dug out and spread there to dry. They are boiled afterwards in a big earthen pot. The hearth is a peculiar one. A trench five yards long, one foot wide and two feet deep, is dug; ten pots each having a capacity to hold ten seers of raw turmeric are placed in a line on it. The rhizomes are dumped in, and a quantity of cow-dung water sufficient to form a layer of three inches thickness over and above the level of rhizomes, is added. The mixture is then heated and boiled. In about five hours the tubers become very soft and pulpy. The boiling should be perfect and complete, as otherwise, the turmeric is liable to be attacked by insects and spoilt. Water is then carefully let out from the pots and the tubers are spread to dry on the threshing yard. They are left to dry there for five days and five nights. It is believed that the turmeric gains in colour if left in the open overnight and hence it is not removed during nights. The ground on which turmeric is allowed to dry is generally enclosed so as to keep away cattle which, if the turmeric is not thus protected, may tread upon it and cause serious damage. Raw turmeric is dull yellow in colour while the boiled and dried sample has a light yellow hue. The dung particles sticking to the tubers are removed by rubbing them with gunny rags.

The average turmeric yield per acre can be estimated at 480 maunds, the finger-like rhizomes occupying the major portion (360 maunds) and the central stalks forming the rest (120 maunds). The ratio of raw products to the boiled and finished product is as 3 : 1.

Besides the two varieties of marketable turmeric that have been referred to above, there is a third variety which is known as *ajji arisina* in the local vernacular. The poorly developed branches of the rhizomes are separated and cut into slices. They are not boiled. This variety is red in colour and is used in the manufacture of the crimsoned powder (*kunkumam*) with which the Hindus mark their forehead. This variety is soft and pliable and inferior to the other two varieties. Five maunds per acre is about the average for this variety.

Processing of turmeric.—Boiled and dried turmeric is pale yellow in colour. As it is not attractive to the customer it cannot fetch a good price. The following special treatment is given to make the commodity more attractive: A small quantity of dried turmeric is beaten to rough powder in mortar by means of a pestle. This powder is then ground to a fine paste in the same mortar adding water little by little during the operation. Alongside with this paste, a cold drawn tamarind water of medium consistency is also prepared. In this tamarind water, which is well mixed with a ladleful or two of the turmeric paste, the turmeric to be marketed is soaked for about ten minutes and then dried. This processing gives a fine yellow tinge to the product. If the paste or tamarind solution is of a thicker consistency than necessary, the paint sticking on the root stalks will be rather thick. Hence the preparation should be of medium consistency.

Turmeric is attacked, although rarely, by leaf blight when the leaves turn yellow and there is no development of rhizomes. Villagers believe that this is due to some goddess being offended and to atone for this, propitiatory services are carried on at such times !

Cost of Cultivation for Ten Guntas of Turmeric.

All items of expenses are charged to the account of the ryot, not excluding the labour contributed by his family.

	Rs.	A.	P.
Ploughing (5 times at 4 as.)	1	4	0
Marking rows (1 man)	0	4	0
Cattle manure (10 cart-loads at Re. 1 per cart-load)	10	0	0
Tank silt (30 cart-loads labour lump sum) ..	5	0	0
Planting (3 men)	0	12	0
Seed (30 maunds at Re. 1 per maund) ..	30	0	0
Weeding once	0	12	0
Digging drains all round	1	8	0
Irrigation (once)	0	4	0
Earthing up (5 men)	1	4	0
Harvesting (8 men)	2	0	0
Miscellaneous work attended to afterwards	7	8	0
Assessment (wet)	1	8	0
Total ..	62	0	0

Yield.

	Rs.	A.	P.
Finger-like rhizomes (30 mds. @ Rs. 2 per maund) ..	60	0	0
Seed (30 mds. @ Re. 1 per maund)	30	0	0
Ajji-Arisina	5	0	0
Total ..	95	0	0

Therefore approximate net profit for 10 guntas of turmeric is Rs. 33, or Rs. 132 per acre.

Arachis hypogaea, Linn.
Groundnut or Peanut

ORIGINAL HABITAT AND ITS DISTRIBUTION IN THE WORLD.

BY

V. K. Badami, L.Ag., Ph.D. (Cantab.)

The origin and distribution of groundnut was shrouded in mystery for centuries. It was as mysterious as the manner in which it produced the pods below the surface of the ground. There has been much confusion over this subject amongst the Botanists of the 19th century. Botanical surveys in Brazil, and archæological excavations in Peru during the last century have yielded valuable and interesting facts which shed much light upon many doubtful points.

It is now definitely known that groundnut existed in South America as a cultivated crop long before the advent of the Spaniards in that continent. The basin of the mighty Amazon where the plant kingdom still reigns supreme and the highlands that surround this vast tropical forest have bestowed on mankind many valuable gifts. Four of the most important ones are potato, groundnut, cinchona and rubber. They are yielding products of great economic importance to the well-being and progress of the world. While potato and groundnut are feeding people with cheap and nutritious food, and quinine has made it possible to develop the resources of the tropics, rubber has become indispensable to the progress of modern civilization. The origin and movement of vegetable forms is as romantic as any chapter of human history, of discovery, of travel or of adventure.

It is here proposed to bring together all available information from scattered literature, in order to obtain a clear and connected idea as to the original habitat and subsequent distribution of groundnut.

It is not known how the word *Arachis* came to be applied to groundnut. The similarity of this word to the Greek word *arachidna* has led to a good deal of misunderstanding. The plant referred to by Pliny as *Oetum* and the long-rooted plant mentioned by Theophrastus were probably one and the

same plant which was generally known as *arachidna*. The ancient Egyptians used to gather these plants at the time of the inundation of the Nile for crowning their altars. It is now believed that the plant referred to was *Lathyrus amphicarpous* and not *Arachis*.

If the plant referred to by the ancient writers was groundnut, it is hard to understand how such a valuable crop as this has disappeared from Egypt. According to Alph. de Candolle, a plant which is provided with such an efficacious and very peculiar manner of germination does not seem in nature to become extinct. Forskōl has not mentioned it in his *Catalogue of Egyptian Plants*. Prospero Alpini has not described it. No reference to it has been made by Delile in his *Flora of Egypt*.

Linnæus gave the habitat of groundnut as Surinam, Brazil and Peru. But he did not state whether it was wild or cultivated. In 1818 R. Brown did not believe that the plant mentioned by the ancient Greek authors was groundnut. He thought that it was not a cultivated crop in Egypt in those days. On the one hand, he believed that groundnut was taken from Africa to equatorial America, and on the other hand, mentions that it is referred to by some of the earliest writers on America, especially in Peru and Brazil. He considered that it was not unlikely that *Arachis* was indigenous both to Africa and America. If only one of the Continents were to be considered as its original home, he was of opinion that Africa was that home. If introduced to Africa it might have come from China and Japan through India by way of the Malay Archipelago. He was probably guided in this statement by the vernacular names of *China badam* (China almond) in Bengal and "*Manila Kottai*" in Madras, meaning manila nut.

Andre' Alvares de Almada, in his *Travels in 1594* and his *Travels in Senegambia in 1564*, states that he found considerable quantities of *Arachis* in the Archipelago of Bujagoz (Bissagos) off the West African coast. Fielto also thought that it was a native of Africa.

Father Merolla in 1642 described a plant in the Congo under the name *mandois* and said that it had three or four seeds together like those of vetches but they were produced underground. They were said to be as big as ordinary olive seeds and milk similar to that drawn from almonds was extracted out of them. It is probable that this plant was *Arachis,* and that by this time it had already spread over the West African coast. By the time Hawkins and other captains began to ship slaves to America, *Arachis* had already become established in Africa and usually the slave ships carried groundnut, Bombaranut (*Voandzia subterranea*) and sweet potatoes to feed the men. Along the slave and trade routes it began to spread all over America and wherever the conditions were favourable it rapidly got into cultivation.

According to Bretschneider no mention of *Arachis* is made in ancient Chinese works nor in the *Pent sao* published in the 16th century. Its introduction into China was probably in the 18th century. It has no antiquity in Asia. Rumphius saw it in Ambonia in 1691 and described it as *Chamæ balanus Japonicus,* says it was imported from Japan into the Indian Archipelago, but Thunberg does not mention it in his *Flora of Japan.* If it were of Chinese origin as Alph. de Candolle said, there was plenty of time for its introduction from China into Japan as these countries had dealings with one another for over sixteen centuries. Loureiro in 1790 called it a native of Cochin China. Forster does not mention it amongst the plants of small islands of the Pacific Ocean. The vernacular names in China, Japan, Dutch East Indies and Cochin China are all equivalent to earth-nut or earth-bean.

Japan = Nankin-nut Java = Katiang ;

There is no name for it in Sanskrit and most of the modern vernacular names in India are all translations of the word groundnut. In Bengal, it is called *China badam* or China almond. In the South Arcot District of Madras where it is largely grown, it is called *Manilla Kottai,* and *Kottai* means a nut. It is explained that this name is a corruption

of "*Manali Kottai*" which means "the sandy soil nut". The plant is indeed referred to by the name *manali* in an allegorical sense in South Arcot. "Two sisters, *Nili* (Indigo) and *Manali* (groundnut) contended for predominance and eventually *Manali* prevailed." Indigo was largely grown in those parts. The discovery of synthetic Indigo ruined Indigo planters but in Southern India groundnut took its place, and began to spread rapidly with the increasing demand from Europe. The Tamil-cultivator is full of such allegorical statements. In other parts it is called *Ver Kadalai* or *Nila Kadalai* or other names equivalent to them, meaning ground gram or root gram. *Kottai* in Tamil means nut and the word *manilla* certainly seems to have other meanings than the one drawn from a rather romantic allegory. Either it may refer to the town Manila in the Philippines or it may be derived from the word *mani*, the American Indian name for groundnut in the language of the *Antilles* of Peru. It may be safely presumed that it is not a native of India. As regards Western Asia no mention of it has been made by any of the ancient Arab authors. Neither Asia nor the Pacific Islands seems to be the original home of *Arachis*.

In Cuba groundnut was found cultivated in gardens by Oviedo (1513-1524), Director of Mines. Jean de Lery described it unmistakably about the same time. French colonists sent in 1555 to the Brazilian coast by Admiral Colingy became acquainted with it by Garcilasso de la Vega in 1609 as being raised by the Indians as a crop under the name *yanchic*. "The fruit is raised underground", he says "and is very like marrow and has the taste of almonds." Groundnut was figured by Loeb in 1625. Maregraf and Piso described the plant and figured it in about 1648 A.D. They thought it was indigenous to Brazil and stated it was called by the Indians *mandubi*. They also quote Manardis, a writer of the 16th century as having indicated it in Peru under a different name, *anchic*. Maregraf does not say whether it was wild or cultivated, but Piso writes that the species was planted. Piso in his second edition gives the figure of a plant

imported from Africa into Brazil under the name *mandobi,* the fruit of which is similar to that of *Arachis.* The similarity of this name to *mandubi,* the Brazilian for *Arachis,* has probably led to confusion. The figures show a plant which has three leaflets and which looks like *Voandzia* so often cultivated in Africa, but the fruits are a little longer than in that genus and contain two or three seeds instead of one or two. Piso, however, drew a distinction between the two subterranean seeds, Brazilian and African. Joseph Acosta mentions it in 1598 amongst the indigenous plants of South America and gives the name *mani* mentioned above. *Arachis* is not ancient in Guiana, West Indies or Mexico. Aublet mentions it as being cultivated in the Isle of France. According to de Candolle, Hernandez does not mention it, but Sloane saw it cultivated in Jamaica from seeds got from Guiana.

In 1825, de Candolle admitted that the origin of *Arachis* was undoubtedly American. Bentham has shown that there are six species belonging to this genus in Brazil. *A. pusilla* is found growing in shady places on the *serra jacobina* in the province of Bahia. *A. prostrata* is found creeping on the surface in open sandy places, in South Brazil, Uruguay and Paraguay. *A. villosa,* a perennial with a woody stalk, is found in great abundance on dry, loose sand near Rio de Janeiro, and in South Brazil and Uruguay. *A. glabrata* is found in marshes in the province of S. Paulo. *A. marginata* is found in sub-humid places on the banks of the Rio Grande and Rio Pardo. *A. tuberosa* with perennial-rhizomes is found near Cimapua on the Rio Pardo. *A. guaramitica* was found by Chodat in the hollows of Siera de Maracay in the Zebsles Mts. As Alph. de Candolle said: "It is impossible for one species common to both the hemispheres to have all the other well-known species placed in a single region of America. It would be a great exception to the law of Geographical Botany." In no excavation in Africa has *Arachis* been found either in the graves or in other places. While Pizzaro made no mention of *Arachis* as one of the seeds he found in the

tombs of Ancon, Rochebrune states that he found groundnut amongst a large number of edible and commercial plant products. These tombs are about 25 kilometres to the north of Lima in Peru. Rochebrune gives an ample list of the cultivated plants and other plant products in use before the Conquest of Peru by the Spaniards. J. Adams gives a figure of the groundnut found in the tombs of this place. E. G. Squier, a U.S. Commissioner to Peru, gives a vivid description of his discovery in the tombs at Pacha Camac, South of Lima. "During my residence in Lima I visited the ruins of Pacha Camac, twenty miles south of the capital. . . . Pacha Camac is one of the most notable spots in Peru, for here, as we are told by the old chroniclers, was the sacred city of the natives of the coast before their conquest by the Incas . . . . In Pacha Camac, the ground around the temple seems to have been a vast cemetery. Dig almost anywhere in the dry nitrous sand, and you will come upon what are loosely called mummies but which are the desiccated bodies of the ancient dead . . . . I will record what I found in a single tomb, which will illustrate how a family not rich, nor yet of the poorest, lived in Pacha Camac. . . . . Besides the bodies, there were a number of utensils, and other articles in the vault ; among them half a dozen earthern jars, pans, and pots of various sizes and ordinary form. One or two were still incrusted with the soot of the fires over which they had been used. Every one contained something. One was filled with groundnuts familiar to us as peanuts ; another with maize, etc., all except the latter in a carbonized condition." Since the natives of the coast inhabited the country long before the Incas and in their time groundnut was a crop of some importance and daily use it must have got into cultivation in remote ages. The evidences revealed at Ancon and Pacha Camac indicate for groundnut a great antiquity as a cultivated crop in South America, or at least they prove the existence of the plant in South America before the discovery of that Continent by Europe. All floras of Asia and Africa mention *Arachis hypogæa* as a cultivated crop. Bentham after satisfying himself that it had not been found wild in

America or elsewhere, suggests that it is perhaps a form derived from one of the six other species found wild in Brazil; but does not say from which.

If in addition to the discovery of groundnut in the graves of Peru a large number of varieties were under cultivation or allied wild forms were present in that region, one would at once fix Peru as the probable original habitat. Such evidences are, however, wanting and it is likely that the cultivated forms were secured from the neighbouring tribes living on the eastern slopes of the Andes.

A large number of species belonging to the genus *Arachis* is still found in various places in Brazil from the regions round the mouth of the Amazon, along the east coast to Uruguay and on the slopes of mountains in the interior as far as Paraguay. Indian tribes in Brazil grow groundnut in several localities and they must have had it in cultivation from remote times. The fact that no remains of this plant have been found in tombs in this region does not disprove this assumption. In moist tropical countries few remains of ancient civilization can be found. The capital of Pataliputra in the Indo-Gangetic plain was one of the biggest cities in the world before the Christian Era. But no trace of it is left behind. Death and decay remove all traces of previous activities of man in these regions.

Prof. I. Baldrati states that in 1905, the *Boletin de Agriculture* of Sau Paulo in Brazil gave a description of a species of groundnut under cultivation which was different from that of *Arachis hypogœa*. In 1926 Lobbe described a species of groundnut cultivated by the Nambyquara Indians as *A. nambyquara*. This was discovered by the Roxdon Commission in the course of their botanical explorations in the region. Prof. F. C. Hochene introduced it into the State of Sau Paulo, and from there it has been introduced into the United States. The seeds vary in shape and colour and the plant gives a yield 3 or 4 times as large as that of *A. hypogœa*. Seeds of *A. nambyquara* are put to the same use as that of groundnut seeds.

The presence of a number of species of *Arachis* in their wild state, the cultivation of groundnut by the Indian tribes and the discovery of other species of *Arachis*, which are under cultivation and the products of which are put to the same use as groundnut go to show that the original habitat of this plant is Brazil; it has spread from there along the great ocean routes to all parts of the World.

Presuming Brazil as the origin of *Arachis hypogæa*, its movement can be fairly well reconstructed and followed.

In South America *Arachis* spread from Brazil to Peru in the west, to Argentine in the south and Guiana in the north. From Guiana it seems to have been introduced to Jamaica, Cuba and some other W. India Islands. From Peru along the land trade routes across the Isthmus of Panama *Arachis* seems to have gone to Costa Rica and Mexico. As already stated, the Peruvians called the plant *yanchi* and the Spaniards called it at first *mani*, a name given to it by the Antilles, and afterwards *mandubi*. They borrowed from Mexico the name *caca hualt* which the Aztecs used for *coca*.

The introduction to North America did not take place directly from South America. Slave ships brought back *Arachis* from the west coast of Africa to the eastern shores of the States of Carolina and Virginia. After the Civil War soldiers returning home took it north and south from Virginia and grew it in small patches as a garden crop. Its extended use and utility as a rotation crop in cotton fields are making it a very important one in the Gulf States.

From Brazil it went to the west coast of Africa. From Senegal and Gambia it reached the upper reaches of the Niger and spread along the coast as far down as Angola. From the mouth of the Niger it moved on towards Lake Tchad, Darfur and Kordafan to Sudan. From Sudan it spread to Egypt in the north, to Eritrea in the east and to Uganda in the south. The existing name in Egypt *Ful Sudani* suggests that it was got from Sudan. In 1834 it was recorded by N. Bove in Cairo that groundnut was a botanical curiosity.

Mohammed Ali seems to have introduced it into Egypt after one of his expeditions to Sudan.

The name *tiga* is an abbreviation of *mantiga*, a word used by the *mandingo* race from Senegal to the borders of Kong in the hinterland of the Ivory Coast. J. Adam says that *mantiga* in Portuguese signifies butter and the Portuguese name seems to have been assimilated into the local Mandingo language. This name is not known in Darfur, Kordafan or in Sudan and possibly they did not receive the nut from the upper reaches of the Nile. On the other hand, in northern Nigeria the Haussa name for groundnut is *geda*. It is not even similar to the word *Paruru*, the name given for *Voandzia* which is commonly grown there as Bambara-nut. How the name *geda* came to be applied to groundnut is not known.

Sudan seems to have got the nut from the Haussa land. The nuts themselves are like those grown in Senegal and Brazil with spreading branches. Caravans from the Niger water-shed frequently penetrated into Egyptian Sudan with Kola nuts. Groundnut must have been introduced by these caravans intentionally or by accident. J. A. Gillan, Government Inspector in Kordafan, gives an Arab legend regarding its introduction from the West. "In pre-Mohammedan times a certain *Wad el Soda* went from Arabia to Dar Borgu in Northern Nigeria, where he became *Hakim el Balad*. During his rule there was a great famine, and many died for want of food. One day a man, in milking a cow, accidentally spilled some milk, and shortly afterwards a previously unknown plant sprang up from the spilled milk, and the nuts which were yielded from this plant seem to have saved the people from complete starvation." This plant according to the legend was the original *ful sudani*, called *abudhin* or *abu leban*. The colloquial name for the plant is still *abudhin* in Kordafan. Old inhabitants agreed that it came from the West, but the date of introduction and the exact locality were not known to them. They say in Kordafan that it was brought by pilgrims going west by way of Darfur.

R. Brown's statement that groundnut reached Africa from the East is also probable in that the east coast of Africa from Mozambique to Zanzibar received their consignment from the Malay Islands and the nut had reached those islands from Peru. The northern coast of Africa received its supply from Portugal and Spain. It is now grown practically all over Africa where climate and soil are suitable. Zones of heavy rainfall in the Congo Valley and the coastal plains of West Africa round the Gulf of Guinea and the vaults of South Africa with their early frosts are not suitable for its successful growth. But in the valleys of Senegal and Gambia, in the upper reaches of the Niger and round Kano it has become a crop of great commercial importance.

From Peru it journeyed across the Pacific along with the expedition of Magellan in 1519-21 to the Molucca Islands and the Philippines. From the Philippines groundnut was taken to Indo-China and Japan through China. In some parts of Japan it is even now known as Nankin mame or Nankin nut. From Celebes in the Moluccas, it spread to all the Malayan Archipelago and to the east coast of Australia. From these islands or from China it was taken to the Malay peninsula, Siam, Burma, Bengal and the east coast of South India. By about 1800 it was already under cultivation even in the interior districts of Mysore. In another line it travelled from the Malay Archipelago to Ceylon on one side, and across the Indian Ocean to Madagascar and to Mozambique on the other. From these places it slowly spread to all the parts of the east coast of Africa including the coastal inlands. A study of the herbarium specimens at Kew shows a remarkable resemblance between plants from Paraguay, Bolivia, Guatemala, Mexico, the Philippines, China, Java, Madagascar and Mozambique. The old Mysore variety of South India also is very much like these in having the stems hairy and with a tinge of violet colour. In about 1800 the seeds of groundnuts were taken from Mozambique to the West Coast of India. When the groundnut was badly deteriorating in South India, consignments from Mozambique and

Mauritius saved the groundnut industry of the country and helped to stimulate its cultivation. Till the oil seed trade in France developed and exploited the possibilities of groundnut, there was no great demand for groundnut in India. When the Suez Canal was opened a great stimulus was given to the export trade of groundnuts in India and the crop spread to all the districts in peninsular India. It has now become a very important commercial crop in the Peninsula building up the prosperity of the ports of Madras, Pondicherry, Cuddalore and other smaller seaside towns having a coastal trade.

This movement both eastward and westward from America meeting in the African continent was the main cause for a good deal of confusion in attempts to discover its place of origin and its distribution.

At present its area is enormous and is still increasing. Its utility, as an edible nut producing a high grade oil, is extending its cultivation in the tropics and in various places it is becoming recognised as a useful crop for rotation with cereals. To dry land farmers or farmers who have no irrigated lands to raise crops like sugarcane, groundnut is becoming important as a money crop. It is even saving the cotton plantations after the spread of the Bollweevil in the United States of America. The increased consumption of peanuts in various forms and as peanut butter in the United States of America has been a great incentive to its extended cultivation there.

Groundnut was grown for the first time in Europe by Stisser in 1697 in Brunswick. It was grown under glass in England in 1712. In 1723 it was grown in the Royal gardens at *Mont Pillier,* but it soon died out. Groundnut was again grown in England in 1774. In 1769 Sir William Watson showed pods and oil to the Royal Society and read a memoir communicated to him by George Brownrigg of N. Carolina. In 1787 great quantities of groundnut were brought to Spain and Portugal from U. S. A. and cultivated. Again Don Ulloa, Archbishop of Valentia, imported large quantities into Europe. Tenore tried it in Italy. In 1801 Lucien Bonaparte,

the ambassador at the Court of Madrid, sent seeds to M. Mechin, Prefect of Landes (prov. of Bordeaux). It succeeded on sandy soils. M. Mechin circulated a detailed account of its cultivation. It was largely grown in south-eastern part of France but the political troubles during 1805 to 1815 checked its spread and eventually it dropped out of cultivation. In 1807 the oil of groundnut was used for soap-making and as a substitute for almond oil. In 1820 and 1822, owing to the destruction of olive gardens by frosts, attempts were made in France to revive its cultivation but, owing to bad organization, there was no market for the oil and the attempt failed. In 1839–40, M. Chaise grew it successfully in France on about twelve and a half acres. Experimental trials were also made at Dase. Losonez grew it successfully in Hungary. The crop was good but it did not pay. At present it is grown as a field crop in Spain and Italy. Other parts of Europe have not the heat necessary for growing it as a field crop in the open.

Groundnut is now grown on a large scale in all the sub-tropical and tropical countries mentioned below, but the most important ones are U.S. of America, India, Senegambia, French Sudan, Nigeria and China.

1. *Europe.*—Portugal, South of Spain specially in Valencia, parts of Italy, Sicily and Crimea.
2. *Africa.*—Senegal, Gambia, Seraleone, Nigeria, Angola, Transvaal, Rhodesia, Nyassaland, Mozambique, Madagascar, Natal, British East Africa, Eritrea, Sudan, Kordafan, Darfur and Egypt.
3. *Asia.*—India, specially in Madras, Bombay, Mysore and Hyderabad; Burma, Malay States, Siam, Annam, Tonkin and Cambodia; the following ports in China export it:—Chinkiang, Canton, Shanghai, Chefoo, Pakhoi, Teinshin, Swatow, Szechwan, Lungchow, and Hong Kong; and Japan.

Malay Archipelago.—Java, Philippines and Celebes.

4. *Australia.*—New South Wales, Queensland and the northern territories of South Australia.
5. *Islands of Pacific Ocean.*—Hawaii and Fiji specially.
6. *North America.*—States of U.S.A., *viz.*, South California, Arizona, New Mexico, Texas, Iklahoma, Indiana, Louisiana, Arkansas, Missisippi, parts of Missouri and Kentucky, Tennessee, Alabama, Florida, Georgia, North and South Carolina, Virginia and Maryland; Mexico, Central American States.
7. *South America.*—All over South America down to about 30° S. Latitude.
8. *West Indies.*—Jamaica, Cuba, Antilles and Barbados.

Consumption of groundnut in Europe is ever on the increase. Its rich oil is wanted for the manufacture of margarine, soaps, and as a substitute for olive oil. The valuable oil-cake useful for fattening animals and for feeding milch cattle is ever in demand and is becoming more and more popular every day. As a manure for plantations in the Tropics for rice fields, sugarcane and market gardening crops, its cake, rich in nitrogen, is eminently suited. Round about Paris market gardeners use it freely. The demand for all these products is so great now that the world's supply is not sufficient and the prices are mounting. To meet this increasing demand fresh areas are being brought under cultivation every year. In large parts of Africa, the cultivation is still primitive and in other places heavy taxation, want of transport facilities and adequate supply of labour are checking greater production. Early ripening varieties are required for the Veldts of South Africa which suffer from early frosts, and for Argentina. The United States of America produces groundnut as a seed crop only in the warmer regions. In other parts it is grown only for fattening pigs. An improvement in the general methods of cultivation, harvesting and marketing; better transport facilities by way of roads and railways in places of production and shipping facilities to take the produce

to the European markets, building up of suitable new types of plants for various localities, will stimulate the production of this important crop and will make available to the world's need more of this nutritious, yet cheap, food.

Editorial

With this number closes the fifteenth volume of this Journal. We avail ourselves of this opportunity to convey our grateful thanks to all our subscribers and contributors for their continued support and co-operation.

Besides acting as an unofficial organ of the Department of Agriculture, the Journal has been striving all these years to serve as a medium through which the members of the Agricultural and Experimental Union can exchange their views and experiences on matters pertaining to agricultural improvement in their respective localities. We have been somewhat disappointed, we have to admit, at the meagreness of the response we have so far had from our members in this regard. Very few members are availing themselves of the facilities afforded by the Union to try on their lands some one or other of the improvements the Department is recommending from time to time and fewer still are making the results of their trials available for publication. If this is due, as we have reason to believe it is, to the innate modesty of our agriculturists in making them believe that their work is exclusively their own and is not of sufficient public importance to deserve publication in a Scientific Journal run under the auspices and with the co-operation of a technical department of Government, we wish to correct that impression and assure the members of the useful part they will be playing in making their experiences—their successes and their failures, their trials and their results—known to their brethren engaged in the same work as themselves but possibly in localities and under circumstances somewhat different

from their own. Highly valuable as is the work the Government Department is conducting in its laboratories and experimental farms in indicating general lines of improvement that could be effected in our agricultural practices and methods, no less valuable are the results of carefully laid out trials on the ryots' own fields in testing the conclusions arrived at by the Department and finding out their suitability or otherwise to the varying climatic and other conditions obtaining in different parts of the State. To make every one of our Members into an experimenter and convert his field into a demonstration farm and thus speed up the progress of agriculture a hundred times, is our earnest desire. We sincerely hope that our Members will realize the importance of their own work and make the fullest use of the opportunity before them for service in the cause of Mysore Agriculture.

SELECTIONS & ABSTRACTS

Changing the Sex of Papaw Trees

The results obtained at Hawaii Experiment Station when 22 perfectly sterile staminate papaw trees on being decapitated produced a new growth which was strictly feminine and the trees bore large fruits, have now been confirmed at Jodhpur. From four plants, all male, the cluster of leaves at the top were removed so that no auxiliary male shoots might develop, and in all four cases strictly female trees resulted. One is bearing large fruits and the three others have produced female flowers.

Though according to some observers decapitation never produces the desired result, it should be tried before cutting down the male papaw.

—*Journal of the Jamaica Agricultural Society*, Vol. XXXIX, No. 5.

Tobacco: A New Source of Citric Acid

The chief supplier of commercial citric acid for many years has been Italy, where the main source of the supply is lemons ; in 1929, Italy exported 2,810 tons of citric acid. Countries requiring large amounts of citric acid have naturally sought to use their own raw materials, and numerous investigations have been made in order to discover suitable and cheap substances and simple means for their transformation. In the United States of America, as well as in Europe, molasses have been successfully employed for many years as a source of citric acid. The application of the fermentation process, involving the fungus *Aspergillus niger*, for converting the sugars in molasses into citric acid was first attempted in 1893. Since then, the process has been put on a sound commercial basis, and the product has competed severely with the natural citric acid obtained from citrus fruits, such as lemon and lime.

Recently, tobacco has been employed as raw material for the manufacture of citric acid in Soviet Russia. Low grade tobacco may contain as much as four per cent. of citric acid combined with bases to form citrates. Some strains, such as Mahorka, contain up to eleven per cent. (Lime juice contains about seven per cent. and lemon juice, between two and six per cent. of citric acid). A high degree of correlation apparently exists between the amount of citric acid present in tobacco leaves and the content of mineral substances (ash), as well as the content of nicotine. Hence the citric acid content of tobacco may be

increased within certain limits by heavy manuring with suitable mineral substances. Mahorka tobacco may be used, not only as a profitable source of citric acid, but also as a source of nicotine. This additional purpose increases the commercial value of the plant, and lessens the cost of the citric acid manufactured from it. The process of extraction is very simple and inexpensive, and involves no fermentation stage.

—*Tropical Agriculture,* Vol. XII, No. 2.

Attitudes of High School Seniors towards Farming and other Vocations

The information upon which this report is based was furnished by 924 white and 566 negro high school seniors who answered in 1932 and 1935, respectively, a questionnaire presented to them. The white seniors in 37 high schools in 20 counties and the negro seniors in 15 high schools in 15 counties co-operated.

A larger percentage of the white than of the negro youth studied lived on farms while attending high school. The parents of 51.2 per cent. of the white and 51.1 per cent. of the negro students studied had received education above the elementary grades.

Forty and four-tenths per cent. of the white and 25 per cent. of the negro youth studied were favourable in their attitude to farm life.

The percentages of the youth of both the races desiring to live on the farm were higher for the children of owner than of non-owner farmers. Sixty-nine and three-tenths per cent. of the white and 71.2 per cent. of the negro youth studied agreed that farm life had pleasant aspects not incident to city life. Enjoyment of nature, the healthfulness of country life, freedom, independence, and home-farm production of food ranked high in the estimation of both races as attractive conditions of farm life.

Outstanding among the reasons given for leaving the farm were low farm income, frequent lack of modern farm and home equipment, and the belief that cities offer more attractive economic, social, and educational opportunities than the country. The lack of adequate rural educational advantages was instanced more frequently by the negro than by the white students.

The percentage of boys who expected to attend college was greater than the percentage of girls who planned to do so. A smaller percentage of the sons and daughters of white parents engaged in farming planned to attend college than was true of the sons and daughters of white parents in non-farming occupations.

Engineering led as the professional choice of the white boys and teaching as that of the white girls. Among the professions teaching

was the first choice of both the negro boys and girls who planned to attend college.

Farming was the first occupational choice of the white boys and nursing of the white girls who had no expectation of going to college. The percentage of white boys choosing farming as an occupation was higher for boys not anticipating college attendance than for those who expected to attend. Apparently the negro boys who did not expect to attend college were more uncertain as to the occupational openings ahead of them than the white boys not planning attendance. The number of negro boys choosing each occupation listed by them was too small to indicate any unanimity of opinion. Nursing led the occupational choices of the negro girls of the group not expecting to enter college.

The desired additions to high school courses cited by the subjects of this report were almost all vocational.

Vocational expectations expressed by students showed no indication of knowledge of demand in the various fields.

The data gathered from the white seniors in 1932 were supplemented by information secured in the year 1935. In the first mentioned year, 31.7 per cent. of the sons of farmers named farming as their future occupation, but in 1935, it was found that 44.3 per cent. were engaged in agriculture.

In 1935 a large proportion of these who were graduated from high school in 1932 had not found their places in the working world.
—*Bulletin No. 302,* June 1935, of South Carolina Agricultural Experiment Station of Clemson Agricultural College, South Carolina.

Cooking American Varieties of Rice

Leaflet No. 12 of U. S. Department of Agriculture.

The leaflet gives some facts about the American rices and suggests a number of recipes to serve rice alone or in combination with meats, fish, milk, cheese, eggs, vegetables and fruits. We as rice eaters in Mysore are well acquainted with preparations of rice with vegetables, pulses and condiments, and it may be interesting to note that the Mysore types of rices also are being tested by the Agricultural Department here for the cooking qualities and suitability for different preparations like pop corn, puffed rice and beaten rice.

In the United States rice is produced on a commercial scale in Lousiana, Texas, Arkansas, and California. The rice varieties are of three types, the long-grained type, the medium-grained and the short-grained. The variety produced and sold in largest quantity is Blue Rose, a medium-grained type. All the varieties are on the market as white rice, and some also as brown rice. Brown rice is the whole

kernel with only the outer husk removed and while it is considered to have higher food value and more flavour than white rice because of the bran and germ portions, it is said it does not keep so well as white rice as it contains more fat which makes it more likely to become rancid and infested with insects. White rice is obtained by further milling of brown rice and the white kernels are often coated with substances that give a pearly lustre, which are however harmless and easily washed off before cooking. Rice polishings are rich in iron and other minerals; they contain Vitamin B and some Vitamin G as well as the fat and protein from the bran and germ portions of the kernel and they may be mixed with corn meal or wheat flour and used in the making of bread, rolls, biscuits, muffins and cookies. Since polishings may soon become rancid they are not usually carried in the stores but can be obtained at the rice mill.

Boiling is one of the most trying tests for rice. In properly boiled rice the kernels are tender but whole, they keep their own distinct shape and in colour they are white or creamy. In cooking quality the American rices ranked as follows with cooking time as indicated in each case :

Rexoro, long-grain (16 minutes), Fortuna, long-grain (21 minutes), Blue Rose, medium-grain (22 minutes), Caloro, short-grain, (20 minutes), Edith, long-grain (22 minutes), Lady Wright, long-grain (23 minutes), and Early Prolific, medium-grain (24 minutes). Because different varieties of rice require different lengths of time for cooking, it is advised that they should not be mixed.

One cup of uncooked rice yields about 3 1/3 cups of boiled rice. Creamy rice : Rice cooked in milk or in a mixture of half milk and half water is creamy and has a pleasing delicate flavour—and higher food value than when cooked in water alone. For cooking in a double boiler 4 to 5 times the volume, and over direct heat 5 to 6 times the volume of liquid to rice is to be used.

M. V.

Potato Growing in Victoria*

No. 5. The Use of Artificial Fertilizers

BY

J. T. Ramsay, *Potato Expert*

The second method of increasing soil fertility and crop yields is the application of artificial fertilizers, most of which are inorganic chemical compounds. There is a wide range of these fertilizers on the

*For previous articles on this subject *vide* Vol. 13, No. 3, Vol. 14, Nos. 1 and 4, and Vol. 15, Nos. 2 and 3.

market, supplying either singly or in combination, many of the essential elements for plant growth. The only elements it is necessary to add to soils used for potato-growing are nitrogen, phosphoric acid, and potash. Formerly lime was regarded as being beneficial to the crop, but exhaustive tests in a variety of soils have disproved this belief. In fact, in the majority of cases where lime is applied to the crop, not only is there no benefit in yield, but an actual decrease occurs. The explanation of this is that the potato plant prefers an acid to an alkaline soil, although the optimum degree of acidity has not yet been determined. It is proposed to have experimental work in regard to this aspect of potato culture carried out in the future.

Of the three ingredients referred to, the most important is phosphoric acid, Victorian soils as a class being markedly deficient in this element. Next in order of importance is nitrogen. Potash is of least consequence. These fertilizers are obtainable in varying forms, the principal of which are detailed as follow :—

Phosphatic Manures

Superphosphate containing 22 per cent. phosphoric acid—mostly water-soluble.

Basic phosphate, containing 17 per cent. phosphoric acid—mostly citrate-soluble.

Nitrogen Manures

Sulphate of ammonia, containing about 20 per cent. nitrogen.

Nitrate of soda containing about 15 per cent. nitrogen.

Dried blood, containing from 8 per cent. to 11 per cent. nitrogen according to quality.

Potassic Manures

Sulphate of potash, containing 50 per cent. potash.

Muriate or Chloride of potash, containing 60 per cent. potash.

Compound Manures

Nitro superphosphate containing from 14 per cent. to 16 per cent. phosphoric acid, and about 2 per cent. nitrogen.

Bone and superphosphate, containing from 14 to 18 per cent. phosphoric acid, and from 2 to 4 per cent. nitrogen.

Blood and bone, containing about 14 per cent. phosphoric acid and 5 per cent. nitrogen.

Superphosphate and ammonia ("6 and 1") containing approximately 18.5 per cent., phosphoric acid and 3 per cent. nitrogen.

Superphosphate and ammonia ("3 and 1") containing 16.5 per cent. phosphoric acid and 5 per cent. nitrogen.

Certain new synthetic manures in highly concentrated form have

become commercially available during the past few seasons, but while these are quite effective as a means of increasing yield, their cost at the present time is prohibitive, and for this reason they cannot be recommended.

There are certain forms of the various chemical manures in use which are more suitable for application to the potato crop than others, either because of their influence on quality or production, or both. The best form in which to apply phosphoric acid is as superphosphate. This fertilizer has a considerable beneficial influence on the table quality of the potato, and a still greater influence on the yield. In fact, owing to the general deficiency in phosphoric acid of Victorian soils, it ranks as the most important of all artificial fertilizers. When used alone it has the effect of shortening the period of maturation of the crop by from two to four weeks. This is most important to growers who wish to have their crop on the market as early in the season as possible, in order to secure the high prices usually obtainable then. It must be pointed out, however, that the shortening of the growing period by the application of superphosphate alone, is accompanied by a sacrifice in yield as compared with that obtained from a combined phosphoric and nitrogenous fertilizer. The use of superphosphate alone by growers catering for the early market resolves itself into a gamble as to whether a smaller yield per acre at a higher price will be more profitable than a heavier yield at a lower price.

Another reason why superphosphate is the best form in which phosphoric acid can be applied to the potato crop, is that it is practically all water-soluble, and therefore becomes immediately available to the crop in its earliest root movement. Tests have shown that the potato crop takes its nourishment from the soil at a much faster rate in the early stages of growth than later. Consequently if the best results are to be obtained, it is essential that the manures given shall be available from the time the plant starts feeding on the soil. Phosphatic, unlike nitrogenous, manures, are not lost by leaching.

Nitrogen should be used only in the form of ammonium sulphate or as dried blood. When used as nitrate of soda, the result usually is to produce tubers of lower table quality. Further, the high solubility of sodium nitrate permits of its being leached from the soil by heavy rains, and thus lost to the crop. Ammonium sulphate is not so readily soluble as nitrate of soda, but acts quickly enough to enable it to be assimilated as required by the crop.

For years potash was considered to be an essential fertilizer for the potato crop, but under Victorian conditions it has not been successful in increasing potato yields. Recent reports of research work in other countries indicate that its value there is being questioned. Despite its

effect on the weight of the crop, it has a beneficial effect on the table quality of the potato, provided that the sulphate form is used. If applied in the form of muriate or chloride, the quality is lowered, even when so small a quantity as 1 cwt. per acre is used.

The soils of this State for the most part are fairly well supplied with potash, and although their potash content on the average does not come up to the apparent requirements of the crop (as determined by soil analysis and by estimate of the potash requirement of the crop by tuber analysis), it would seem, from data secured from the experimental work carried out on various classes of soil for a number of years, that there is ample potash in an available form to suit the demands of the crop under normal Victorian climatic conditions.

The following table shows the amount of nitrogen, potash, and phosphoric acid contained in a 6-ton potato crop (tubers only) :—

Six Tons Potatoes

Nitrogen.	Potash.	Phosphoric acid.
67 lb.	77 lb.	24 lb.

This means that a 6-ton crop takes from the soil, approximately the equivalent of 3½ cwt. nitrate of soda, 1½ cwt. of sulphate of potash, and about 1 cwt. superphosphate. From this analysis it will be seen that the drain on the soil elements made by the crop is greatest on potash.

It should be noted that the above table gives merely the amount of the three principal elements removed by the 6-ton crop. It is probable that much greater quantities of each are necessary in the soil for the development of this yield. The actual chemical content of the tuber portion of the crop therefore can scarcely be accepted as a guide in estimating the quantity of manure required to produce it.

The particular forms of chemical manures to apply, and the rates per acre at which they should be used, have been the subject of considerable experimental work by the Department of Agriculture. The production of heavy crops of any kind would be a much simpler matter if an all-sufficient formula of manure could be stated, but owing to the varying compositions of soils, abrupt variations of which are often to be found in one paddock, it is impossible for a standard manure, efficacious and economical in all classes of soils to be given. The only reliable guide is an actual field test with varying quantities of the standard fertilizers. Tests of this nature have been carried out by the Department in various districts, and the results obtained are summarized below.

Time of Application

The correct time of application of artificial fertilizers is at the planting of the crop. The correct place is in the furrow with the seed,

whether planting is done by hand or machine. It is estimated that any quantity of manure in the furrow is equal to at least half as much again broadcast either before or after sowing. The explanation of this is that when in the row with the seed, the manure is available from the time of the first root development. If broadcast, the root systems of plants have to extend the full width of the rows, 26 to 27 inches, before complete contact with the manure is made.

The trials conducted by the Department include the testing of manures in varying quantities and combinations over a wide range of soils, and much data have been obtained in regard to the manurial requirements of this crop. When these trials were instituted at various centres in the State, a range of manures and rates per acre, based on the estimated potato crop manurial requirements of each separate district, was drawn up for trial at each centre.

After some years the manurial variations in kind and rate per acre were standardised. The soils in which the experiments were conducted embraced volcanic, peat, clay, and light and heavy loams. In each of these classes of soil there was considerable difference, so that (with the exception of light sand) the soil range included practically all types in which potatoes are grown to any extent in Victoria.

Excepting in irrigation districts, few potatoes are grown in localities with an annual rainfall of much less than 30 inches, as, for successful yields, the potato crop needs an abundance of moisture during its growing period. A striking illustration of this is seen in the heavy yields recorded during the 1930-31 season throughout the potato-growing districts, which then had their heaviest rain for years. The one exception to this was the Ballart District which suffered severely in that season from phenomenal summer frosts.

Victoria has a combination of soils and climate well suited to the production of potatoes, although with a heavier summer rainfall the average production per acre would be greatly increased. The presence of water in the soil is imperative for the maximum functioning of both the manures and the root systems of the plants. Plant foods in the soil are assimilated by the roots and transmitted to the over-ground portions of the plant in the form of sap, and consequently, if the absorption of plant food is to take place readily, the amount of water necessary to supply the needs of the crop must be present. The greatest authentic yield per acre of potatoes in Victoria (25½ tons) was obtained in a wet season.

During the period when manurial trials on potatoes were made at Werribee under irrigation (the Werribee rainfall averages less than 20 inches per annum) the influence of moisture on the crop was demonstrated very strikingly. Owing to seepage from the channel

carrying the irrigation water to the crop, a few rows of potatoes adjacent and parallel to the channel, were saturated with moisture practically throughout the season. The yield from these rows was approximately 10 tons to the acre, while the remainder of the crop produced approximately 7 tons to the acre, notwithstanding the fact that during the period of the trial the whole area had been given 18 inches of water by irrigation, in addition to several inches of rain.

In some potato-growing countries, artificial manures are applied (in addition to stable manure) at the rate of up to a ton to the acre, with improved results, but such heavy rates of application would not produce a corresponding increase in Victoria, except in seasons of phenomenally heavy summer rainfall. When manurial trials were first instituted in this State up to 9 cwt., superphosphate was applied, both alone, and in conjunction with nitrogenous and potassic fertilizers, but it was soon found that this rate was much in excess of the quantity that could be absorbed by the crop in a normal season.

Although manures influence quality in potatoes, the greatest factor in this regard is the class of soil in which the crop is grown. The class of soil which produces the most floury type of potato are the loams in districts of good rainfall. Clay loams or swampy lands, except in very dry years, rarely produce a floury potato, although they may produce an attractive and palatable tuber. Essentials for good keeping quality in potatoes intended for the table are perfect drainage, thorough ripeness, and harvesting in cool weather in the autumn.

—*Journal of Agriculture, Victoria,* Vol. XXXI, Part 12.

Termites or White Ants

'White' ants are not true ants although these look like ants and live in colonies made up of different forms. Fifty-six species of them occur in the United States. They are distributed throughout the country, although in the Southern, South-Western and Pacific coast regions where both the subterranean and non-subterranean kinds occur they are more numerous and injurious than elsewhere. Termites in the United States are mainly species of subterranean or wood-boring habit and are not so spectacular or common as the mound-making or tree-nesting termites of the tropics.

The Colonizing Swarms

At certain seasons, usually spring or fall, but varying with the species and the locality, the winged, sexual individuals migrate in large numbers from the parent nests. They then lose their wings and breed new colonies. In the case of the subterranean termites, wood and trees are usually entered indirectly through the ground, although sometimes these insects enter trees under bark loosened by sunburn, etc., or

through scars or borer holes, provided sufficient moisture is present. Non-subterranean termites enter the wood directly, or in the case of trees, through wounds or borer holes or under loose bark ; moisture is not necessary.

In the new quarters eggs are laid, the young develop, and in a few years the colony increases in numbers, and the workers are able to feed and care for the reproductive forms—the "King" and "Queen"—as well as the soldiers which are sterile forms adapted to protect the colony from insect enemies, notably the true ants. In recently formed young colonies the rate of egg laying is slow, but mating is repeated, and although there is at first a gradual increase, later the increase in the numbers of the broods is rapid. In old colonies there are thousands and tens of thousands of individuals.

Egg laying occurs over a considerable period during the warm months in colonies out of doors. In infested buildings artificially heated, where an even temperature is maintained, the insects are active and may lay eggs every month of the year. The number of eggs laid depends on the age of the queen.

The Reproductive Forms

Owing to the increasing number of eggs that develop within her the queen becomes enlarged, but never loses the power of locomotion. It was once believed that, since the queen mother was the source of the colony life, the termite colony would be exterminated if she were destroyed, but this has been disproved by more recent studies. In addition to the forms that have shed their wings, several different types of reproductive forms occur—forms with wing pads (the undeveloped wings of the nymphs) and wingless reproductive adults. The winged forms, however, are the normal type and occur as a single pair, whereas there may be hundreds of the other forms heading colonies. The reproductive forms with wing pads and the wholly wingless type usually have little colour in the body, and the eyes are small. These forms rarely come above ground or leave the burrows in wood.

The location of the queens in the colony depends upon the season of the year. During periods of intense heat or drought in the plains or in arid or prairie regions the subterranean termites burrow deeply below ground or to a less depth under stones, cow chips, etc. During the winter in the colder climates they burrow below the frost line.

Whole colonies of subterranean termites migrate when conditions become unfavourable. The non-subterranean termites, on the other hand, are not able to leave the wood in which they have excavated their nests.

Preventing and Remedying Damage to Woodwork of Buildings

1. Clearing the building site of all decaying wood and stumps,

burning the soil, and killing the subterranean termites if present with 10 per cent. solution of Sodium Arsenite, a well-strained mixture of 1 part coal-tar and 3 parts kerosene oil, carbon disulphide emulsion, orthodichlorobenzine (50 gallons per 1,000 sq. ft.) or live steam.

2. Complete insulation from the ground of all untreated woodwork of buildings so that the subterranean insects may not secure the contact with moist ground necessary for their living.

3. Having foundations, flooring and superstructures as well, entirely of stone, brick, concrete, concrete and steel, or timber impregnated with coal-tar creosote specially where it comes into contact with the ground.

4. Avoiding dampness by laying concrete floors over gravel base and in other ways.

5. Using wood chemically treated with zinc chloride, chlorinated naphthaline for interior woodwork, furniture, etc., specially against the non-subterranean insects.

6. Sometimes spraying attacked timbers with orthodichlorobenzine (which should be done carefully not allowing the chemical to drip down) or blowing the insects galleries by means of bellows with Paris-green or Sodium Fluosilicate if not entirely replacing the structure by the chemically treated wood.

Besides city building codes are suggested for urban communities.

Preventing and Remedying Injury to Living Vegetation

(Fruit, Nut, Shade and Forest Trees)

Termites cause occasional but serious injury to individual living trees, shrubs, nursery stock, and grapevines. In case of shade trees the infestation may start as local at the base and extend more generally through the heartwood. A wise preventive measure is the removal of all loose wood which may afford them shelter, such as prunings, dead and dying trees, and the like, and untreated fence posts and similar material.

Termites are also occasionally a pest in orchards, not only in new orchards planted on freshly cleared land where there is such debris, but also, because of neglect, in old orchards, in both Florida and California.

Cleanliness in orchard and forest management is important. Since termites in the Southern States render unmerchantable the forest trees that have been killed by insects, fire, or disease, all timber from such trees should be utilized or removed as promptly as possible in areas where termites are common.

In the case of the pecan it is recommended that 2 or 3 cereal crops be grown on newly cleared land before the young trees are set out.

Tree Surgery

Properly executed tree surgery sometimes is effective in repairing

injury by termites to valuable old fruit and shade trees. The termite-infested wood should be carefully cut out, and the dead heartwood should be given a brush treatment with coal-tar creosote. This treatment should not extend to within an inch of the living sapwood. Then the cavity should be filled with a suitable material.

Covering Scars and Pruned Areas

To prevent infestation, care should be taken that the trees do not become scarred, especially near the base. Scars and all pruned areas should be treated with a mixture of one-fourth creosote and three-fourths coal-tar. This mixture should not be allowed to come in contact with the living tissues at the edges of the bark ; to protect them a shellac should be applied.

Commercial Fertilizers

Soil heavily manured will attract subterranean termites, since they can obtain food from the animal manure; commercial fertilizers should be used in preference in regions where termites are common in the soil.

Young Plantations or Nursery Stock

Injury to nursery stock from 1 to 3 years old will be more serious on recently cleared land and where decaying wood is abundant. Any debris in which the insects breed should be avoided in planting nursery stock. Earth used in banking should be free from rotten wood. Care should be taken not to allow the roots to dry out before being planted, as weakened stock is specially susceptible to attack ; particular care should be given to grafted stock.

Insecticides

When valuable trees are infested but not yet dying, subterranean termites can be killed in the soil, if it is moist and not too compact, by breaking it up near the tree and pouring carbon disulphide on the earth at a distance of about a foot from the trunk, and then covering the liquid over with earth. The gas from this liquid will penetrate the subterranean galleries of the termites. It is somewhat dangerous to plant life, and very large doses should not be used. *Care should be taken in handling this volatile fluid, as the gas or vapour from it is highly inflammable and explosive when mixed with air in certain proportions ; no flame should be brought near it, and the fumes should not be inhaled, as they are poisonous.* There are indications that an emulsion of carbon-disulphide, which is on the market ready for use, may prove more effective than carbon disulphide alone ; as in the case of the disulphide itself, the earth is loosened up and the emulsion poured on, at least a foot from the tree. Carbon tetrachloride, the gas from which is neither explosive nor inflammable, can be similarly used but is apparently not

so effective as carbon disulphide. The gases from carbon disulphide and carbon tetrachloride, being heavier than air, will not readily rise.

Where non-subterranean termites are infesting living trees, they can be poisoned with dry paris-green.

Vineyards

In vineyards all dead or diseased vines should be removed. All exposed areas left by pruning should be painted with preservative coatings, and the prunings should be burned promptly. Nearby stands of tree windbreaks should be carefully cared for and kept free from infestation by termites. Trellis posts should be creosoted.

Field and Truck Crops

(Deep Fall Ploughing)

Deep, late, fall ploughing will be of value in breaking up the galleries and nests of subterranean termites on ground planted to field or truck crops. Irrigating the land, where practicable, will be effective; this can be done before planting the crop.

Burning Stubble

Care should be taken not to plough under stubble which will serve as food for termites ; it should be burned. The use of commercial fertilizers instead of animal manure is also recommended where subterranean termites are common in the soil.

Rotation of Crops

As a result of the frequent stirring of the soil, rotation of crops will aid in preventing termites from injuring them. Ploughing and fallowing are more practical than the use of insecticides in preparing the soil to prevent termite damage.

Flowers and Greenhouse Stock

Termites injure a great variety of flowers in gardens, as well as many plants grown under glass in greenhouses, where the warm, moist atmosphere maintained throughout the year promotes greatly the activity of the insects. Injury from termites is especially common where the plants are perennial and have woody stalks.

Sources of Infestation

Heavily manured flower beds are a source of infestation to the stems of the flowers as well as to the woodwork of buildings near by, if suitable protection is lacking. Termites can obtain food from the animal manure. Untreated wooden stakes used as support of plants often become infested, and in time the insects attack the plants. Where greenhouses have already been built and termite damage is due to poor construction termites often attack old label sticks, the wooden uprights

supporting wooden benches set on or in the ground, and the wooden bench bottoms and plant pots, and later attack the growing plants. The insects come up through the ground and form dirt galleries over the supports, or burrow up through the wooden bench legs and run galleries the full length of the benches. They enter the soil in the pots through the drainage holes and eat out the main stalk of the root, killing the plant very quickly.

Proper Construction of Greenhouses

Proper construction of greenhouses will practically safeguard plants growing in them from all injury by termites. Iron frames and concrete work should, wherever possible, replace bricks or woodwork. In cases of infestation of old greenhouses, all wooden uprights supporting wooden plant benches should be sawed off, if set on or in the ground, and rested on stone, bricks, or concrete, above the surface of the ground. Proper repairing, including the removal of all infested wood, will prevent the plants from becoming infested in turn. Where woodwork is necessary the wood should be impregnated with zinc chloride or bichloride of mercury ; it can be painted after treatment. Wood impregnated with coal-tar creosote cannot be used with safety in greenhouses.

Avoiding Stable Manure

In flower gardens, especially those located near the woodwork of buildings, commercial fertilizer should be substituted for stable manure in order to protect not only the buildings but also the growing plants.

Insecticides

Either carbon disulphide or carbon tetrachloride can be used to kill termites in the soil if it is moist and not compact. These gases should not be used too near the infested plants, or the plants should be removed temporarily until the soil has been treated. Small holes should be made near the infested plants and a small quantity of the liquid chosen poured in and the holes immediately closed tightly with earth. Calcium cyanide has also been found effective, but it should not be placed near living plants ; it mixes readily with and enriches the soil and gives off an insecticidal gas which *should not be inhaled, as it is poisonous.*

An effective control may be found in the use of kerosene nicotine oleate or a 5 per cent. kerosene emulsion. If the greenhouse benches are infested, but for any reason cannot be replaced, they should be soaked thoroughly with this emulsion, as should also the ashes and sand under the pots on the benches. This may be done by removing the potted plants from a section of the bench, spraying that section, and moving the pots on the bench to cover the treated area, thus giving

access to another section. Potted heliotropes and geraniums have been treated directly with the 5 per cent. kerosene emulsion without injury to the plants, and the white ants in the soil of the pots were all killed. The soil should be wet down before this spray is used. This treatment should be given late in the afternoon and be followed early the next morning with a thorough syringing of the soil with water to wash out the surplus oil. It is important to remove all infested pots from the bench as soon as the infestation is noticed and to destroy the termites with kerosene emulsion.*

—U.S. Department of Agriculture Farmers' Bulletin No. 1472.

Agricultural Marketing in India

BY

Dr. B. V. Narayanaswamy Naidu, M.A., Ph.D., B.Com., Bar-at-Law

Professor of Economics, Annamalai University

Importance of Marketing.—The phenomenal fall in the price of agricultural produce in recent years has drawn pointed attention to the problems of marketing of agricultural produce in this country ; and it can scarcely be doubted that among various other operative causes, national and international, the lack of proper marketing facilities in this country have an important share in bringing about this great landslide in prices. The fall in prices could have perhaps been minimised with better arrangements for marketing ; at any rate it is beyond doubt that even in the most prosperous of times producers in this country were never able to get the maximum price for their products.

Disabilities of the Peasant Producer.—It is a common phenomenon in this country to find the agriculturist trying to sell his produce as soon as the harvest is over even though the market is glutted with the same goods and the prices have fallen. He undertakes to do this since he has often to meet the insistent demands of his creditors, to pay the kist, or other seasonal obligations, or has no facilities for safe storage and hence he invariably sells at the lowest price and thus gets a very scanty return for his labours. This is not his only disadvantage ; lack of standardised weights and measures, absence of grading, want of proper inspection of goods, secret settlement of prices by agents and brokers, have all gone against the interests of the producer. False and incorrect weights and measures are often used and the Punjab Banking Enquiry Committee found that out of 1,407 scales and 5,907 weights

*Kerosene emulsion is made as follows : Kerosene, 2 gallons ; fish-oil soap, ½ pound ; water, 1 gallon. Dissolve the soap in hot water and pour in the oil slowly, with constant stirring to emulsify. Dilution : If 37 gallons of water be added to the above stock emulsion it will give 40 gallons of 5 per cent. kerosene emulsion.

examined by them 69% of the scales and 29% of weights were incorrect. Even if the weights and scales were correct the presence of a large variety of local weights and measures only tends to confusion and loss in marketing. Prices are often cut down on the ground that goods are not according to specifications and the absence of a proper system of inspection makes it difficult to locate the fault. The illiterate peasant is often deceived by the secret bargaining of agents and brokers since he is not in possession of detailed knowledge of the market. Large quantities of things are taken from him as samples without any payment. Another disadvantage he labours under is that he is asked in many towns and rural centres to pay a heavy impost for charities and various other purposes.

The Place of Internal Marketing.—These are a few of the difficulties of internal marketing ; and this is of paramount importance to the Indian producer in view of the fact that out of 1,200 crores to 1,300 crores worth of agricultural produce in British India the internal market accounts for more than a thousand crores while foreign markets take only 200 to 300 crores worth of agricultural goods. Let us now consider the difficulties of external marketing.

Defects of External Marketing.—The most outstanding feature of external marketing is the lack of a well-directed and unified selling organization. This has been detrimental to the indigenous seller in that the unsettlement in quality and specifications has often resulted in an ignorance in other countries of the real quality of his goods and their extent as well as in his getting much lower prices than his goods could otherwise have secured. Not only has there been no proper advertisement of his goods in foreign countries but an impression has even gained ground in other countries that India cannot supply high grade products. This latter has been in some measure due to variations in specifications and manipulations of standards. Improved methods of advertisement, proper grading and branding of goods and the establishment of trade agencies in foreign countries are obvious remedies for these evils.

Essentials of Marketing ; Sellers' Co-operative Societies.—These difficulties cannot be overcome without taking into account the essential functions of marketing, *viz.*, collecting and assembly, transportation, wholesale distribution, retailing, risk bearing and financing in all stages. The present wasteful method of individual selling of agricultural produce has to be given up in favour of collective and co-ordinated selling for improved credit and storage which can be best secured by the establishment of Agricultural Co-operative Marketing institutions. Having regard to the exceptional economic conditions of our country it can very well be realised that sellers' co-operative organizations are more vital to the best interests of the people than even buyers' co-operative

societies. This will prevent the dumping of agricultural produce in the market by the ill-informed and impecunious individual producer or the restriction of its supply and artificial raising of the prices by the moneyed speculators. The poor agriculturist need no longer sell his goods soon after the harvest for want of proper storage facilities. The selling organization will help to get him credit till his goods are sold, store his products, and release them for sale at proper intervals. If we take rice for instance we find that though the demand for it is constant in provinces like Madras and Bengal, there is excessive supply and lowering of prices at some seasons and comparative scarcity and higher prices at other times. The sellers' association can advance money to the cultivator on the security of his goods, provide for storage, and arrange to release the goods at favourable times.

The need for such organization.—Apart from all these, such organizations can improve the merchandizing practices, help in the careful grading of commodities, provide for improved methods of advertisement, regulate the quality and quantity of supplies to different markets, increase the bargaining power of the farmer (for, an individual seller cannot bargain as effectively as the manager of a co-operative association which has in its control large quantities of agricultural produce) and eliminate trade abuses. This will no doubt tend to greater economy in marketing and serve to restrict the activities of the middleman. Thus the great need for establishing selling organizations becomes evident. Such associations may be formed for definite areas and linked together in a central organization.

American Experiments.—The present American experiments in co-operative marketing are of interest in this connection. By the passing of the Agricultural Marketing Act of 1929 the Federal Farm Board was established and stabilisation of commodity prices and price regulation. The Act provides, in addition, to give aid to farmers for forming co-operative marketing associations and the Board has given an impetus to the forming of national associations for each principal crop. The Board has advanced considerable funds for packing-houses, elevators and ware-houses and for mechanical equipments for storage.

Transportation.—In any scheme of sound marketing transportation plays an important part since it is the price of the commodity at the customer's door that matters and not merely its cost of production. In the matter of agricultural marketing, the produce has to be taken from the rural areas to the nearest railway station, thence to the railway terminal and thence distributed to the consumers. Transportation not only gives additional value to agricultural products but it also adds time and place utilities to the commodities thus transported. Experience and enterprise have proved that certain things are produced best and most cheaply in certain areas though the need for them is widespread.

Hence, amidst modern conditions, it is more economical to manufacture them in such areas and transport those goods to all those places where they are in demand and thus contribute to the good of the consumer as well as the producer. The most important agent of transport is the Railway and the complaints have been widespread in this country that freights have been too heavy and facilities for transport inadequate. The Central Banking Enquiry Committee in their Report say that it costs Re. 1-3-0 to send by rail a maund of wheat from Calcutta to Lyallpur while the freight from Australia to Calcutta is only six annas. This hampers the free flow of goods within the country and indirectly sets a premium on imported articles. The importance of Railways in the marketing structure of a country can scarcely be overestimated in that the efficient and reliable service rendered by the railroad reacts on the actual and relative rates which determine the markets for various goods. So, in foreign countries, various methods of transportation, *viz.*, railroads, waterways and truck services are encouraged and special transportation services such as refrigerator cars, fast freight lines and express service make it possible for goods to be delivered quickly, cheaply, and in good condition. This widens the market for certain goods and prevents their reaching the destination a day after the fair. Therefore there is a great need in this country to improve communications, to increase transport facilities, and to decrease the freights.

Storage.—Another important aspect of marketing is storage. Storage has been a necessity from the earliest of times in order to conserve the supplies of goods during times of plenty so that they may be utilised in times of scarcity. It helps to adjust seasonal production to needs of continuous demand and acts, as it were, as a reservoir in order to insure an even supply to meet the recurring needs. Two methods of storage are in existence in other countries : (1) a chain of Government warehouses, and (2) a licensed system of private storing houses. Of these, the system of private warehouses seems easier and cheaper to work. All important centres of agricultural production should have warehouses of their own which may be entrusted to reliable and capable men having the necessary accommodation and willing to furnish a reasonable security. Such warehouses should be licensed by a licensing board consisting of the representatives of Government and of local business interests including agriculture. Warehouse receipts have been recognised as valid securities in other countries and therefore the financing of agriculture can be rendered easier by this method. Perhaps it may be objected that increased facilities for storage and warehousing may encourage restrictive and speculative activities ; but this can be prevented by provision for a system of periodic release of produce by lots or rotation. Warehouses in the proximity of railway

stations may be built by the railways themselves or by private agency with the help and encouragement of the Railway Board. With legislative sanction railway receipts giving full details of the goods deposited may even be used as negotiable instruments.

Grading, Standardization and Simplification.—Grading, standardization and simplification of products come next in importance in the organization of marketing. In the case of India, however, these are of utmost importance since she has yet to build up in other countries a reputation for the high quality and reliability of her products. Sales to foreign buyers can be effected only by the help of samples or by description. Grading and standardisation give exactness to such descriptions and eliminate the possibility of error or misunderstanding. Standardisation seeks to introduce a uniform system of measurement of quality as well as quantity. The first aspect involves grading while the second secures a reliable system of weights, measures and specifications. Simplification tries to restrict the classification of goods into as few varieties as possible. The advantages of such processes are that the graded product secures for the producer the highest price that he can legitimately get, and enables him to create a demand for it and ensures to the purchaser the quality that he prefers. Needless to add that all these go to facilitate market finance operations.

State Action.—Various measures in regard to these aspects of marketing have been adopted in America where the Federal Trade Commission and the Bureau of Standards have been attempting to establish certain definite standards. The Federal Pure Food and Drug Act has aided greatly to enforce the purity of food products. Nor have private agencies been behind-hand in this direction. In this country also, fraudulent action has been sought to be prevented by Government but these attempts have been neither thorough nor systematic. A stringent enforcement of the Food Adulteration Act and the extension of the Madras Commercial Crops Markets Act of 1933 are much to be desired.

Marketing Finance.—The importance of marketing finance has been widely recognised. Every marketing transaction requires funds and hence there is a great need for the expansion of mercantile credit in India. Proper financing of marketing operations can alone secure regularity of supply and adequacy of prices. The scope for such financing is very great in India in view of the limited facilities that banking offers in this country. In the United States of America one of the most recent types of specialised financial institutions is financing companies for the marketing of goods. A proper study of these methods will help the introduction of similar institutions in our country also.

Remedies.—The lack of proper marketing facilities has been a great handicap to the Indian producer in this competitive age and a

good deal has to be done to enable him to come to his own in the markets at home and abroad. The very grave handicap of indebtedness has to be removed by providing cheap capital and favourable terms for repayment. Attempts should be made to introduce standard weights and measures throughout the country. The cultivator has to be educated into a knowledge of the value of grading and standardisation so that he realises that only by these means his goods can fetch a higher price in foreign markets. Adulteration has to be stamped out and liberal provision made for the building of warehouses and storage accommodation. Insurance of goods against various forms of risk has to be enforced, market financing fostered and developed and information regarding crop reports and market price quotations made available to the cultivator in his own vernacular so that he may be guided properly in his future action.

Responsibilities of Government and Public.—A larger part of this has to be shouldered by Government. Prevention of adulteration and enforcement of standardised weights and measures must be primarily the concern of Government. The Government must appoint provincial marketing officers to collect and co-ordinate marketing information and make it available to the producers. Government should also help to establish marketing boards in each province on a regional basis to work in co-operation with the marketing officer. In order that the producer may have a common place for discussion of such problems as finance, production and marketing, regional agricultural chambers have to be established. Thus, it is clear, that in the organization or marketing in India the Government and the people have to take their proper share : the people by establishing co-operative sales societies and by co-operating in marketing boards and in the collection of marketing data and the Government by introducing penal and preventive legislation and by the appointment of marketing officers and by the provision of storage and transport facilities.

Conclusion.—There are those who look with suspicion on every extension of Government activity and look upon it as an infringement of age-long rights. While half-hearted legislation and tinkering with one or two aspects of marketing is to be deprecated, increasing interest of Government in the economic ordering of the people is to be welcomed. The days of *laissez faire* and individualism are long gone by and a progressive state can justify its existence only by keeping abreast of the increasing needs of the highly complex conditions of to-day ; and in no direction is wisdom and right planning more necessary than in the organisation of agricultural marketing.

—*The Madras Agricultural Journal,* Vol. XXIII, No. 1.

Our Exchange List

1. Tropical Life, London.
2. The Modern Review, Calcutta.
3. The Mysore Economic Journal, Bangalore.
4. The Madras Agricultural Journal, Agricultural College, Coimbatore.
5. The Implement and Machinery Review, London.
6. The Journal of the Mysore Engineering Association, Bangalore.
7. The Agricultural Gazette of New South Wales, Sydney.
8. Malayan Agricultural Journal, Federated Malay States, Kualalumpur.
9. Review of Applied Entomology, The Imperial Bureau of Entomology, London.
10. Agriculture and Live-Stock in India, Delhi.
11. The Tropical Agriculturist, Peradeniya, Ceylon.
12. Publications of the Department of Agriculture, Colony and Protectorate of Kenya, Nairobi, British East Africa.
13. Bulletin of Deli Proef Station, Medan, Deli (East Coast of Sumatra).
14. International Review of Agriculture, International Institute of Agriculture, Rome, Italy.
15. Publications of the Department of Agriculture and Labour, Government of Porto Rico, San Juan P. R.
16. Lingnan Science Journal, Lingnan University, Hongkok, Canton, China.
17. The Indian Veterinary Science Journal, Madras.
18. Bulletins of Agricultural Experiment Station, State College of Washington, Pullman, Washington.
19. The South African Sugar Journal, Durban, South Africa.
20. Bulletins of the Agricultural Experiment Station, Georgia, U. S. A.
21. Do. Do. University of Maryland, Maryland, U. S. A.
22. Do. Do. New Brunswick, U. S. A.
23. Do. Do. The Pensylvania State College, Pensylvania, U. S. A.
24. Do. Do. Michigan State College, Michigan, U. S. A.
25. Do. Do. University of New Hampshire, Durham, N. H., U. S. A.
26. Do. Do. University of Idaho, Idaho, Moscow, U. S. A.

27. Bulletin of the Colorado Experiment Station, Colorado, U. S. A.
28. Do. the Missouri College of Agriculture, Columbia, Missouri, U. S. A.
29. Do. the Agricultural Experiment Station, Stillwater, (Oklahoma), U. S. A.
30. Do. Do. University of Arizona, Tucson, U. S. A.
31. Do. Do. Brookings, South Dakota, U. S. A.
32. Bulletins of the Agricultural Experiment Station, La Fayette, Indiana, U. S. A.
33. Do. Do. Gainesville, Florida, U. S. A.
34. Do. Do. Newark, Delaware, U. S. A.
35. Do. Do. Fruit Station, Missouri, U. S. A.
36. Do. Do. Corvallis, Oregon, U. S. A.
37. Do. the Virginia Truck Experiment Station, Norfolk, Virginia, U. S. A.
38. Bulletins of the Agricultural Experiment Station, Pineapple Canner's Station, Honolulu, Hawaii, U. S. A.
39. Bulletins of the West Virginia University, West Virginia, U. S. A.
40. Bulletins of the Agricultural Experiment Station, University of Nebraska, Lincoln, Nebraska, U. S. A.
41. Do. Do. University of Montana, Montana, U. S. A.
42. Do. Do. Virgin Islands, U. S. A.
43. Do. Do. Texas, U. S. A.
44. Union Des Agricultures, D'Egypte, Cairo, Africa.
45. Bulletins of the Virginia Agricultural Experiment Station, Blacksbury, Virginia, U. S. A.
46. Bulletins of Agricultural Experiment Station, Island of Guam, Guam, U. S. A.
47. Do. Do. University of Illinois, Illinois, U. S. A.
48. Bulletins of the University Library, University of California, Berkeley, California, U. S. A.
49. Philippine Agriculturist, Laguna, Philippine Islands.
50. Bulletins of the State College of Washington, Western Washington Experiment Station, Puyallup, Washington, U. S. A.
51. Bulletins of the South Carolina Experiment Station, Clemson College, South Carolina, U. S. A.

52. Bulletins of the Agricultural Experiment Station, Logan, Utah, U. S. A.
53. The New Zealand Journal of Agriculture, Department of Agriculture, Wellington, New Zealand.
54. The Journal of the Madras Provincial Co-operative Union, Madras.
55. Industry, Calcutta.
56. Bulletins of the Department of Agriculture, Canada.
57. Tamil Nadu Co-operative Federation Journal, Coimbatore.
58. Publications of U. S. Department of Agriculture, Washington, U. S. A.
59. Bulletins of the Minnesota Agricultural Experiment Station, University Farm, Minnesota, U. S. A.
60. Bulletins of the Imperial Institute, London.
61. Publications of the Imperial Bureau of Soil Science, England.
62. Bulletins of the Rhode Island State College Agricultural Experiment Station, Kingston, Rhode Islands, U. S. A.
63. Cyprus Agricultural Journal, Cyprus.
64. Bulletin of the Pan American Union, Washington, D. C., U. S. A.
65. Journal of the Department of Agriculture of Victoria, Melbourne.
66. Bulletins of the Agricultural Experiment Station, Wooster, Ohio, U. S. A.
67. Bulletins of the Vermont Agricultural Experiment Station, Burlington, Vermont, U. S. A.
68. Bulletins of the Imperial Bureau of Fruit Production, England.
69. Publications of the Science Museum, London.
70. Nagpur Agricultural College Magazine, Nagpur, India.
71. Publications of the Indian Central Cotton Committee, Bombay.
72. The Journal of the Jamaica Agricultural Society, Jamaica.
73. Mayurbhanj Gazette, Mayurbhanj State, India.
74. Bulletins of New York State College of Agriculture, Ithaca, New York.

2044-35.—Printed at The Bangalore Press, Mysore Road, Bangalore City, by G. Sreenivasa Rao, Superintendent.